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Artificial intelligence, the democratization of knowledge and sociotechnical inequalities: a theoretical essay on possibilities and limits of digital inclusion in education

Inteligência artificial, democratização do conhecimento e desigualdades sociotécnicas: um ensaio teórico sobre possibilidades e limites da inclusão digital na educação

Inteligencia artificial, democratización del conocimiento y desigualdades sociotécnicas: un ensayo teórico sobre las posibilidades y los límites de la inclusión digital en la educación

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Abstract:
This theoretical essay examines, in the educational field, the relationship between artificial intelligence, digital technologies and the democratization of knowledge, addressing the tension between broader access to information and the risk of deepening sociotechnical inequalities. It assumes that technology is neither neutral nor automatically emancipatory, since its effects depend on material, cognitive, cultural, institutional and political conditions. The analysis brings together literature on multilevel digital inequality, critical education, artificial intelligence literacy, accessibility, platformization, foundation models, cognitive justice, ethics and regulation, as well as recent Brazilian data on connectivity and educational uses of artificial intelligence. As its contribution, the essay proposes an analytical framework connecting types of technology, levels of access, pedagogical mediation, computational infrastructure and regulation, while distinguishing evidence of adoption from still-untested hypotheses about educational benefits. It concludes that artificial intelligence may contribute to the democratization of knowledge, but that this contribution depends on public policies for connectivity, teacher and student education, school infrastructure and ethical regulation, otherwise risking the reproduction of pre-existing inequalities.

Keywords:
Artificial intelligence; Democratization of knowledge; Digital divide; Educational technologies; Sociotechnical inequalities.

Resumo:
Este ensaio teórico examina, no campo educacional, a relação entre inteligência artificial, tecnologias digitais e democratização do conhecimento, problematizando a tensão entre a ampliação do acesso à informação e o risco de aprofundamento de desigualdades sociotécnicas. Parte-se da premissa de que a tecnologia não é neutra nem automaticamente emancipadora, pois

seus efeitos dependem de condições materiais, cognitivas, culturais, institucionais e políticas. O percurso articula literatura sobre desigualdade digital multinível, educação crítica, letramento em inteligência artificial, acessibilidade, plataformização, modelos fundacionais, justiça cognitiva, ética e regulação, além de dados brasileiros recentes sobre conectividade e usos educacionais da inteligência artificial. Como contribuição, propõe-se um quadro analítico que relaciona tipos de tecnologia, níveis de acesso, mediação pedagógica, infraestrutura computacional e regulação, distinguindo evidências de adoção das hipóteses ainda não testadas sobre benefícios educacionais. Conclui-se que a inteligência artificial pode contribuir para a democratização do conhecimento, mas essa contribuição depende de políticas públicas de conectividade, formação docente e discente, infraestrutura escolar e regulação ética, sob risco de reprodução de desigualdades preexistentes.

Palavras-chave:
Inteligência artificial; Democratização do conhecimento; Exclusão digital; Tecnologias educacionais; Desigualdades sociotécnicas.

Resumen:
Este ensayo teórico examina, en el ámbito educativo, la relación entre inteligencia artificial, tecnologías digitales y democratización del conocimiento, problematizando la tensión entre la ampliación del acceso a la información y el riesgo de profundización de las desigualdades sociotécnicas. Parte de la premisa de que la tecnología no es neutral ni automáticamente emancipadora, pues sus efectos dependen de condiciones materiales, cognitivas, culturales, institucionales y políticas. El recorrido articula literatura sobre desigualdad digital multinivel, educación crítica, alfabetización en inteligencia artificial, accesibilidad, plataformización, modelos fundacionales, justicia cognitiva, ética y regulación, además de datos brasileños recientes sobre conectividad y usos educativos de la inteligencia artificial. Como contribución, propone un marco analítico que relaciona tipos de tecnología, niveles de acceso, mediación pedagógica, infraestructura computacional y regulación, distinguiendo las evidencias de adopción de las hipótesis aún no comprobadas sobre beneficios educativos. Concluye que la inteligencia artificial puede contribuir a la democratización del conocimiento, pero que esta contribución depende de políticas públicas de conectividad, formación docente y estudiantil, infraestructura escolar y regulación ética, bajo el riesgo de reproducir desigualdades preexistentes.

Palabras clave:
Inteligencia artificial; Democratización del conocimiento; Exclusión digital; Tecnologías educativas; Desigualdades sociotécnicas.

1. Introduction

Access to information and the ability to transform it into knowledge have become increasingly central conditions for social participation, the exercise of citizenship and entry into the world of work. In recent decades, the expansion of digital technologies and, more recently and intensely, the accelerated public diffusion of generative artificial intelligence systems since late 2022 have reconfigured the ways knowledge is produced, circulated and appropriated (MIAO; HOLMES, 2023), creating possibilities for learning, research, translation and

pedagogical mediation. At the same time, this reconfiguration occurs in societies marked by profound economic, educational and territorial inequalities, requiring a critical examination of the extent to which artificial intelligence actually contributes to the democratization of knowledge or, conversely, widens distances between groups with and without qualified access to these resources.

The central problem of this essay can be formulated as follows: how can artificial intelligence and contemporary technological resources contribute, in education, to the democratization of knowledge while simultaneously deepening social inequalities when access to these technologies is unequally distributed? The objective is to examine, theoretically and critically, the potential and limits of artificial intelligence as an instrument for expanding access to information, learning and social participation, considering the material, cognitive, cultural and institutional conditions that determine its effective appropriation.

The relevance of this subject stems both from its timeliness and from its educational, social and political implications. Understanding the limits and possibilities of artificial intelligence in the democratization of knowledge is essential if educational institutions, public policymakers and educators are to guide its use in a socially responsible manner, avoiding both the uncritical celebration of technology and its simplistic rejection. This debate extends beyond the technical sphere because it involves choices about who has a voice in defining the educational priorities of a society increasingly mediated by algorithmic systems.

This text therefore adopts neither a technophilic position, which would attribute to artificial intelligence an automatic ability to solve structural problems of educational and social inequality, nor a technophobic position, which would regard technology as an inevitable threat. It assumes a critical, situated perspective grounded in the sociotechnical tradition that understands digital technologies as products of economic, political and institutional choices (CASTELLS, 1999). This orientation converges with critical literature on educational technology, which treats the incorporation of artificial intelligence as a social and political choice rather than an inevitable technical consequence (SELWYN, 2019). Following this introduction, the theoretical and methodological approach, the analytical development organized around thematic axes, the final considerations and the references are presented.

2. Theoretical and methodological approach

This text is a qualitative theoretical essay, a form recognized in scientific production in the humanities and applied social sciences as distinct from bibliographic research, bibliometric

research and review articles. Soares, Picolli and Casagrande (2018) provide a formal delimitation of the genre in relation to these forms by characterizing the essay as the construction of an analytical argument through the critical articulation of theoretical references, without dependence on original empirical evidence or a systematic search protocol. In education, Larrosa (2003) grounds another dimension of the genre by understanding it as a hybrid form of academic writing and reflection capable of questioning established ways of producing knowledge. The references thus serve complementary functions: the former defines the methodological format and the latter situates its reflective potential in education. The aim is neither to exhaustively map production on artificial intelligence and education nor to report original empirical research, but to construct a theoretically grounded argument about the proposed problem.

The selection of literature followed three criteria. First, priority was given to established works in the debate on the network society, critical education and digital inequality, even when they preceded the emergence of generative artificial intelligence, insofar as they offer analytical categories that remain relevant. Second, normative documents and studies published since 2021 were incorporated, including those subsequent to the accelerated public diffusion of generative artificial intelligence from late 2022, to situate the discussion at the current stage of the regulatory, educational and technical debate. Third, to contextualize the discussion in Brazil, recent national data on connectivity, inequalities in the use of generative artificial intelligence and its appropriation by students and teachers, produced by NIC.br's Cetic.br, were incorporated.

The essay employs four organizing analytical axes. The first is the distinction between digital technologies in general, machine-learning-based artificial intelligence systems and generative artificial intelligence systems, treated in the development as technically distinct categories. The second is the model of four types of access proposed by Van Dijk (2020): motivational access, material access, digital skills and use, alongside discussion of tangible outcomes as an associated but analytically distinct dimension, often treated in the literature as a third layer of digital inequality. The third is the concept of cognitive justice, invoked and developed by Santos (2007) in the context of his critique of abyssal thinking. The fourth is the distinction between general digital literacy and specific artificial intelligence literacy, the latter understood as the set of competencies enabling people to critically evaluate, effectively use and understand the limits of artificial intelligence systems (LONG; MAGERKO, 2020).

These axes are applied cumulatively: each section draws on one or more of them to examine a specific dimension of the problem. Table 1 formalizes their articulation in analytical

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questions, potentialities, risks and observable indicators, without converting theoretically plausible relationships into presumed causality.

Table 1: Analytical framework for examining the democratization of knowledge mediated by artificial intelligence

Dimension	**Analytical question**	**Potential**	**Risks**	**Observable indicators**
Technological object	Which system, task, language and audience are being analyzed?	Access, translation, personalization and learning support.	Opacity, biases, generalization and contextual inadequacy.	System or model type; task; language; audience served.
Access and outcomes	At which level is there a barrier or conversion into a benefit?	Qualified use and more equitable educational outcomes.	Adoption without competence or benefit; unequal outcomes.	Input: connection and device. Use: frequency and purpose. Outcome: pre/post performance in a delimited task.
Mediation and literacy	What guidance, education and supervision are available?	Critical, safe, autonomous and pedagogically intentional use.	Dependence, misinformation and reduced pedagogical interaction.	Guidance received; training hours; supervision; response verification.
Infrastructure and platforms	Who controls models, services, data and computational capacity?	Scale, availability, continuity and integration.	Private dependence, unequal access and environmental costs.	Provider and plan; availability; data governance; computational capacity; energy.
Regulation, accessibility and cognitive justice	Which rights, groups, languages and knowledges are considered?	Protection, inclusion, participation and plurality of knowledges.	Discrimination, privacy violations and linguistic or cognitive exclusion.	Legal and accessibility compliance; language coverage; human oversight; participation of affected groups.

Source: authors' elaboration based on Van Dijk (2020), Van Deursen and Helsper (2015), Long and Magerko (2020), Santos (2007), Selwyn (2019), Van Dijck, Poell and De Waal (2018), Bommasani et al. (2021), Blasi, Anastasopoulos and Neubig (2022), Chemnad and Othman (2024) and UNESCO (2021).

The indicators are organized into three levels: input conditions, use and mediation processes, and outcomes. The first two can be described through adoption and infrastructure surveys; outcomes require specific measures and cannot be inferred from usage percentages. In the development, sections 3.1 to 3.4 operationalize the object, access and mediation; sections

3.5 and 3.6 address accessibility and regulation; section 3.7 integrates platforms and infrastructure; and sections 3.8 and 3.9 articulate cognitive justice and implications for educational policy.

The limitations of this essay include the absence of primary data collected by the author, the impossibility of bibliographic exhaustiveness inherent in a text of limited length and the necessarily provisional nature of any analysis of rapidly changing technologies. Although the essay incorporates recent national data from the ICT in Education 2024 and ICT Households 2025 surveys, as well as a sectoral study on artificial intelligence in education, these secondary surveys do not replace empirical investigations specifically designed to test the causal relationships discussed here. Statements about trends and risks should therefore be read as theoretically grounded hypotheses whose verification requires future research in specific Brazilian educational contexts.

3. Development

3.1 Artificial intelligence, digital technologies and access to information: a necessary distinction

Artificial intelligence can be understood as a sociotechnical technology produced by economic interests, material infrastructures, datasets, computational models and specific social practices. This conception avoids treating artificial intelligence systems as neutral or autonomous entities and makes it possible to recognize that their social effects depend on technical, economic and political choices spanning their conception, development and use. In analyzing the emergence of the network society, Castells (1999) had already shown that information technologies do not determine social transformations by themselves, but interact with pre-existing economic and institutional structures, intensifying both inclusion and exclusion processes.

To avoid undue generalizations, it is necessary to distinguish analytically between three categories frequently confused in public debate. Digital technologies in general include connectivity, devices, open educational resource platforms and automatic translation tools, which are not always based on artificial intelligence. Machine-learning-based artificial intelligence systems include recommendation and classification mechanisms trained on historical data and employed for more than a decade in different sectors. Generative artificial intelligence systems, publicly expanded since late 2022, produce text, images or sound using

models trained on large volumes of data, with specific capabilities and risks that the most recent international normative documents seek to address (MIAO; HOLMES, 2023).

Treating these three categories as equivalent undermines the precision of the analysis of the democratization of knowledge because each imposes different conditions of access, use and appropriation. An open educational resource platform, for example, can expand access to information without requiring specific artificial intelligence competencies, whereas the critical use of a generative system presupposes an understanding of how these systems produce responses, their reliability limits and the extent to which their outputs should be verified. This conceptual distinction runs throughout the development of this essay and prevents attributing to generative artificial intelligence effects that actually arise from broader digital infrastructure conditions.

This requirement for terminological precision is not merely semantic: educational research assessing the impact of digital technologies on learning frequently uses heterogeneous samples and methodological designs, combining under the same educational technology label everything from simple exercise platforms to generative artificial intelligence systems. This heterogeneity makes comparison between studies difficult and can lead to mistaken conclusions about the effectiveness or risks of artificial intelligence specifically, when the observed results actually derive from other associated digital technologies. By adopting the tripartite distinction as a cross-cutting analytical category, this essay seeks to contribute to greater precision in this debate, although its systematic application to future empirical reviews requires research efforts beyond the theoretical scope proposed here.

3.2 Democratization of knowledge: educational possibilities of artificial intelligence and their limits

The democratization of knowledge cannot be reduced to simply making content and tools available because it requires processes of critical appropriation involving cultural repertoire, language, available time and adequate pedagogical mediation. Nevertheless, potential contributions of generative artificial intelligence to this process can be recognized, particularly when used to support personalized tutoring, adapted explanations of content, study organization and production of accessible materials, uses that UNESCO itself recognizes as promising provided they are accompanied by regulation on data privacy and age limits (MIAO; HOLMES, 2023).

For students with learning difficulties, language barriers or sensory disabilities, artificial intelligence offers possibilities for supporting accessibility and overcoming communication barriers, although the effectiveness of these uses varies according to the type of educational need, the design of the tool and the available pedagogical mediation, as discussed in greater detail below in the section specifically devoted to this issue.

This possibility coexists, however, with an unresolved debate in educational literature about the limits of algorithmic personalization of learning. While adaptive tutoring systems can adjust the pace and language of explanations to individual needs, UNESCO itself warns that extensive use of these systems without pedagogical supervision can reduce opportunities for dialogic interaction between students and teachers, an element that educational literature associates with cognitive and socioemotional gains that automated systems do not fully reproduce (MIAO; HOLMES, 2023). The potential for personalization should therefore be interpreted as a complementary resource whose effectiveness depends on its pedagogical design, rather than as a substitute for human interaction.

In light of Freire's (1987) dialogic and problem-posing education, it can be argued by interpretive extension, since the author did not address artificial intelligence, that no technology replaces the critical mediation necessary for the appropriation of knowledge. Dialogue and problem-posing are conditions of liberating education that automated systems do not fully reproduce.

The democratization of knowledge mediated by artificial intelligence therefore depends on technological resources being integrated into educational processes that encourage intellectual autonomy, interpretive ability and critical assessment of received information, rather than merely passive consumption of automatically generated content. This condition remains a plausible theoretical hypothesis whose effective magnitude in different educational contexts requires future empirical investigation, especially in public education systems with heterogeneous technological infrastructure.

3.3 Digital exclusion as a multilevel phenomenon: beyond material access

Digital exclusion is a multidimensional phenomenon that is not confined to the absence of an internet connection. Van Dijk (2020) distinguishes four analytically separate, albeit interrelated, types of access: motivational access, referring to interest and willingness to use digital technologies; material access, referring to possession of devices and connectivity; access to digital skills, referring to operational, informational and strategic capacity for use; and use

itself, namely the frequency, diversity and purposes for which digital technologies are actually employed. Literature on the third dimension of digital inequality adds to these four access types an analysis of tangible outcomes obtained through such use, that is, the ability to convert access, skills and use into concrete educational, professional, social and civic benefits (VAN DEURSEN; HELSPER, 2015).

These levels are neither equivalent nor automatically successive: a person may have material access and still fail to translate it into relevant outcomes if digital skills or adequate institutional mediation are lacking. This finding is particularly important for the artificial intelligence debate because programs distributing devices or expanding connectivity, while necessary, do not by themselves ensure that material access becomes qualified use or effective educational outcomes.

In the context of generative artificial intelligence, this sociotechnical inequality can manifest as an asymmetry between students able to use advanced tools with critical autonomy and students without basic infrastructure or training to assess generated content. Based on this asymmetry, the hypothesis is formulated, though not empirically measured in this essay, of a specific inequality in cognitive and educational benefits associated with artificial intelligence use. This hypothesis adds to dimensions already described in digital inequality literature, but its magnitude and concrete manifestations in different school contexts remain open to investigation.

Recent data from the ICT Households 2025 survey reveal inequalities in the appropriation of generative artificial intelligence in Brazil. Among internet users, 69% of class A members reported using these tools, compared with 16% in classes D and E; by educational attainment, use reached 59% among people with higher education and 17% among those with elementary education (NIC.BR, 2026). These data demonstrate differences in use by income and education, but do not permit direct inference of differences in competencies or cognitive or educational benefits. In conjunction with Van Dijk's (2020) model, they support the need to investigate whether, and under what conditions, asymmetries in use become inequalities in outcomes.

Regarding material access, the same survey edition recorded that 86% of Brazilian households already had an internet connection, compared with 83% in the previous edition, accompanied by growth in the proportion of households with fixed broadband, reaching 76% (NIC.BR, 2026). These numbers indicate real progress in the material access dimension in Van Dijk's (2020) sense, but should not be interpreted in isolation: the same survey shows that improved connectivity did not translate into equivalent equalization of generative artificial

intelligence use across income and education strata. This reinforces the thesis that Van Dijk's (2020) four access types evolve at different rates and should not be taken as interchangeable indicators of a population's degree of digital inclusion.

3.4 Digital literacy and artificial intelligence literacy: pedagogical mediation and critical education

Critical appropriation of artificial intelligence presupposes digital, media and information literacy processes that go beyond instrumental training in specific tools. This involves developing the ability to evaluate sources, understand the limits and potentialities of algorithmic systems, recognize possible biases and discern the reliability of information produced or mediated by these systems.

In recent years, international literature has consolidated a specific field devoted to artificial intelligence literacy, distinct from general digital literacy, addressed by both Long and Magerko (2020) and subsequent reviews (NG et al., 2021). Long and Magerko (2020) define this literacy as the set of competencies enabling individuals to critically evaluate artificial intelligence technologies, communicate and collaborate effectively with these systems and use them as tools in different spheres of life, including school. This definition shifts the debate from a purely instrumental perspective centered on knowing how to operate a particular tool to a critical perspective centered on understanding how these systems work, their limitations and how their outputs should be interpreted and verified.

In this process, schools, universities and libraries play a strategic role as public mediation institutions capable of providing infrastructure, teacher and student education and qualified pedagogical support. UNESCO itself recommends that teacher education for critical pedagogical use of generative artificial intelligence should accompany, rather than merely follow, the introduction of these tools into educational institutions (MIAO; HOLMES, 2023). The absence of these institutional conditions tends to reinforce unequal appropriation of artificial intelligence, restricting its benefits to individuals who already have sufficient cultural and technological capital to use it autonomously and critically. This hypothesis reinforces the relevance of specific teacher education policies focused on artificial intelligence literacy, rather than only generic digital literacy.

Curricular integration of artificial intelligence literacy nevertheless faces practical obstacles beyond institutional goodwill. Already overloaded school curricula, a lack of time allocated to continuing teacher education and the speed at which new versions of generative

systems are released hinder the consolidation of stable pedagogical practices around these technologies. This mismatch between the pace of technological innovation and the pace of curricular and educational adaptation is itself a dimension of digital inequality insufficiently explored in the classical literature, insofar as it more acutely affects education systems with less budgetary autonomy and less stable teaching staff.

In Brazilian schools, ICT in Education 2024 showed that 70% of secondary school students already used generative artificial intelligence tools for school research, but only 32% reported receiving guidance from their school on how to use them (NIC.BR, 2025b). The gap between adoption and guidance reinforces that access to a tool does not equate to artificial intelligence literacy and that pedagogical mediation constitutes a dimension of sociotechnical inclusion in its own right.

3.5 Artificial intelligence and accessibility: differentiated potential according to the type of educational need

The relationship between artificial intelligence and accessibility deserves specific treatment given the risk of generalizations treating this benefit as uniform across different student groups. A systematic review of digital accessibility in the era of artificial intelligence, conducted by Chemnad and Othman (2024) through analysis of dozens of studies published between 2018 and 2023, identifies a significant concentration of applications for people with visual impairments, including object recognition systems, assisted navigation and automatic generation of textual image descriptions, alongside a relevant gap in applications addressing hearing impairments, autism spectrum disorders, motor disabilities and other neurological conditions.

This disproportion suggests that the generic claim that artificial intelligence benefits students with disabilities needs qualification: benefits documented in the literature concentrate on certain types of need and certain applications, while other conditions remain less technically explored. The same authors identify recurring challenges including scarcity of training data representative of users with disabilities, privacy issues associated with cameras and sensors, implementation costs and a lack of consistent adherence to established accessibility standards (CHEMNAD; OTHMAN, 2024).

An additional barrier less discussed in technical accessibility literature is linguistic diversity. Language technology performance remains concentrated in a small number of languages with greater availability of computational resources and digital data (BLASI;

ANASTASOPOULOS; NEUBIG, 2022). Although this evidence does not allow direct assertions about these systems' performance in Portuguese or Brazilian Indigenous languages, it suggests that students using languages less represented in digital corpora may face additional barriers when using accessibility resources based on speech recognition or text generation. For these students, linguistic asymmetry may add to the barriers already identified by Chemnad and Othman (2024), constituting an additional form of exclusion spanning both disability and the student's position relative to languages with greater computational resources in system training. The specific effects of this inequality in Brazil's linguistic context still require original empirical investigation.

For education, this literature suggests that artificial intelligence's inclusion potential should be treated as neither automatic nor uniform, but as dependent on the specific educational need, the technical design of the tool, the available pedagogical mediation and compliance with recognized accessibility standards. A school adopting generative artificial intelligence systems without assessing their suitability for different profiles of students with disabilities risks increasing rather than reducing inequalities within the very student group the technology seeks to include.

Initiatives to evaluate and certify accessibility for educational artificial intelligence tools, still incipient internationally and whose consolidation in Brazil was not identified within this essay, could mitigate some of these risks by offering school administrators objective parameters for selecting systems suitable for different student profiles. Without such parameters, decisions about tools tend to rest on cost, popularity or availability in Portuguese, rather than necessarily on consolidated evidence of effectiveness for specific educational needs. This reinforces the relevance of treating accessibility as an explicit dimension of technological inclusion policies, rather than a presumed and automatic benefit of adopting generative artificial intelligence systems in schools.

3.6 Algorithmic biases, privacy and ethical regulation: risks of incomplete digital inclusion

Machine-learning-based artificial intelligence systems, including generative models, are trained on datasets reflecting historically constituted social, cultural and linguistic patterns, which can reproduce biases and stereotypes in their responses and recommendations. In a study of search systems, Noble (2018) demonstrates how algorithmic platforms can reproduce and amplify pre-existing racial and gender discrimination even when presented as neutral tools for

organizing information. This problem requires special attention in educational contexts, where trust in these systems can, without appropriate critical mediation, naturalize discrimination already present in society.

Noble's work adequately supports discussion of private interests, algorithmic discrimination and the non-neutrality of search and recommendation mechanisms, but does not directly address the specific commercial structure of paid subscriptions and free plans characterizing part of the generative artificial intelligence market. This second issue should be treated as a distinct hypothesis: some platforms' commercial structure, marked by differentiation between free plans and paid plans with advanced features, may introduce additional access asymmetries. This hypothesis is consistent with Van Dijck, Poell and De Waal's (2018) broader analysis of platformization, according to which digital platforms penetrate social and economic institutions while concentrating decision-making power over terms of use, access to features and handling of user data.

Privacy and data protection issues become even more sensitive when artificial intelligence use involves children and adolescents, prompting UNESCO to recommend that countries consider age limits and data protection as conditions for regulated use of these tools in schools (MIAO; HOLMES, 2023). More broadly, the Recommendation on the Ethics of Artificial Intelligence, adopted by 193 UNESCO member states, establishes that development and use of artificial intelligence systems must observe principles of transparency, equity and human oversight (UNESCO, 2021). These parameters are directly relevant to educational applications and provide a normative reference for developing school and institutional policies on the subject.

An additional risk, specific to generative artificial intelligence and distinct from the biases discussed by Noble (2018), is these systems' propensity to produce factually incorrect responses presented with apparent certainty, a phenomenon widely discussed in technical literature as hallucination. In education, this risk is particularly sensitive because students may lack the background needed to identify factual inaccuracies in well-written, apparently coherent responses. UNESCO's guidance that educational use of generative systems should be accompanied by critical verification of generated information (MIAO; HOLMES, 2023) directly addresses this risk, reinforcing that the artificial intelligence literacy discussed earlier in this essay is not merely desirable but a condition for safe use in pedagogical contexts.

At the national regulatory level, Brazil still has no specific, comprehensive legal framework for artificial intelligence in force. In education, the National Digital Education Policy, established by Law No. 14,533/2023, sets out the axes of Digital Inclusion, School

Digital Education, Digital Training and Specialization, and Research and Development in Information and Communication Technologies, offering a relevant sectoral reference but not specific artificial intelligence regulation (BRASIL, 2023a). Bill No. 2,338 of 2023, proposing general rules for the development, implementation and responsible use of artificial intelligence systems, was approved by the Federal Senate in December 2024 and, on August 29, 2026, remained under review in the Chamber of Deputies by a special committee with deputy Aguinaldo Ribeiro as rapporteur, without a final vote (BRASIL, 2023b). Until this framework is approved, the General Data Protection Law, the National Digital Education Policy and other sectoral rules comprise the framework applicable to educational use of these technologies, complemented by UNESCO's international recommendations (MIAO; HOLMES, 2023; UNESCO, 2021).

3.7 Platformization, foundation models and the political economy of computational infrastructure

The growing mediation of social life by digital platforms, a phenomenon Van Dijck, Poell and De Waal (2018) call the platform society, has direct implications for education. By incorporating private learning platforms, generative artificial intelligence systems and digital services, educational institutions expand possibilities for personalization and efficiency, but also transfer decisions about data, features and access conditions to private actors. Selwyn (2019) proposes assessing these choices in terms of values, educational purposes and teaching work, rather than presenting them as inevitable technological replacement. In Brazil, Mendes et al. (2026) situate the same tension between pedagogical potential, teacher mediation and the risk of massification, reinforcing that adoption should remain subordinate to the institution's educational project.

This dependence raises questions of governance, continuity, equity and data protection. Platforms and commercial plans may offer different features, but it cannot generally be assumed that paid versions guarantee greater data protection or that free versions necessarily follow a single monetization model. Conditions concerning privacy, retention, model training, feature access and data processing vary across providers and contractual arrangements, and therefore must be examined individually by educational institutions. The analysis of platformization remains relevant because it reveals the concentration in private actors of the power to define these terms of access and use (VAN DIJCK; POELL; DE WAAL, 2018).

In Brazil, the sectoral study Artificial intelligence in education: uses, opportunities and risks in the Brazilian context identified concrete differences between public and private education systems: participants from private schools reported greater familiarity with and access to artificial intelligence tools, while those from public schools reported more intense difficulties with connectivity and equipment availability (NIC.BR, 2025a). The study does not isolate the effect of paid subscriptions but provides empirical evidence that infrastructure and institutional capacity condition educational adoption of artificial intelligence.

Added to this governance layer is the infrastructure of foundation models, defined by Bommasani et al. (2021) as systems trained on large volumes of data and adaptable to a wide range of downstream tasks, of which generative artificial intelligence models used in education are direct examples. The authors highlight two associated processes: the emergence of capabilities not explicitly programmed and homogenization, that is, the tendency for a small number of base models to underpin applications in domains as different as health, law and education, also concentrating technical risks in a few points of failure.

This concentration has a material dimension frequently underestimated in discussions of artificial intelligence in education: training and operating foundation models depend on large-scale computational infrastructure, data centers, specialized graphics processing capacity and intensive energy consumption, resources concentrated in a small number of technology companies. A Stanford University survey identified that in 2025 institutions based in the United States produced significantly more artificial intelligence models classified as notable than Chinese institutions, and that the United States alone had more than ten times the number of data centers of any other country (STANFORD UNIVERSITY, 2026). Van Dijck, Poell and De Waal's (2018) analysis of platformization remains relevant for understanding platform mediation of social life, but the foundation-model layer adds another dependence, located not only at the level of interfaces and terms of use but in the computational infrastructure on which those interfaces are built.

This material infrastructure also entails an environmental cost rarely included in debates about democratizing knowledge through artificial intelligence: intensive electricity consumption associated with operating large-scale data centers, whose rapid growth driven by artificial intelligence expansion has already been documented in technical literature on digital sustainability (DE VRIES, 2023). Although precise measurement of this environmental cost and its distribution across different artificial intelligence uses remain subjects of ongoing technical debate, its existence reinforces that expanding educational use of these technologies entails material and environmental costs. Like the financial access costs discussed earlier, these

are not distributed uniformly between developed and developing countries, nor between those directly benefiting from these tools and those bearing the environmental effects of their global-scale operation.

For Brazilian education, this configuration suggests that schools, universities and public policies tend to depend on infrastructure and models developed by foreign private actors, given the high geographic and institutional concentration of foundation-model development capacity (BOMMASANI et al., 2021; STANFORD UNIVERSITY, 2026), rather than develop foundation models of their own. This technological dependence raises digital sovereignty questions extending beyond the platformization discussed earlier and directly connected to cognitive justice in the next section, insofar as concentrating model development capacity in a few actors also concentrates the power to decide which languages, cultures and forms of knowledge are best represented in artificial intelligence systems available for educational use.

3.8 Cognitive justice and public policy: conditions for effective democratization of knowledge

Effective democratization of knowledge through artificial intelligence depends on public policies for connectivity, equipment, teacher education and development of open educational resources that guarantee minimum conditions for access and critical appropriation of these technologies. Without such conditions, artificial intelligence tends to preferentially benefit individuals and institutions already possessing infrastructure, education and cultural capital, widening distances rather than narrowing them.

The notion of cognitive justice, invoked and developed by Santos (2007) in his critique of what he calls abyssal thinking, connects this discussion to a broader perspective recognizing the diversity of knowledges, languages and forms of knowledge production, and refusing to reduce technological inclusion to a homogeneous measure of access. For the author, contemporary social injustice is closely associated with a global cognitive injustice that hierarchizes knowledges and disqualifies non-hegemonic forms of knowledge.

Transposed to the artificial intelligence debate, this perspective suggests that democratization of knowledge should be measured not only by tool availability but by concrete conditions for participation, production and recognition of historically marginalized knowledges in the contemporary informational ecosystem. An educational policy guided by cognitive justice would not merely distribute access to artificial intelligence systems; it would also address the linguistic and cultural diversity of content produced by these systems,

participation of different social groups in defining technological priorities, and recognition of forms of knowledge not reducible to what these systems can process or reproduce. In an analysis of Brazil, Paixão (2026) connects critical education, educational technologies and social justice, reinforcing that innovations should be assessed through their effects on participation and inequality rather than availability alone.

This dimension of cognitive justice connects with the concentration of foundation-model infrastructure and the inequality of linguistic resources discussed earlier (BOMMASANI et al., 2021; BLASI; ANASTASOPOULOS; NEUBIG, 2022). As indicated in the accessibility section, language technology performance remains concentrated in languages with greater data and computational resource availability, without authorizing direct conclusions about Portuguese or Brazilian Indigenous languages. From the cognitive justice perspective, this asymmetry permits the hypothesis that apparently neutral technical choices can hierarchize languages and forms of knowledge expression best served by educational technologies. Their effects in Brazil nevertheless require specific empirical investigation.

3.9 Implications for Brazilian educational policies

The articulation of theoretical references, systematized in Table 1, with recent national data allows some implications for educational policies in Brazil to be outlined. First, differences in artificial intelligence use by income and educational attainment already recorded in ICT Households 2025 and discussed earlier show that connectivity and device-distribution policies remain necessary, albeit insufficient, conditions for an inclusive strategy for artificial intelligence in education (NIC.BR, 2026).

Second, the distinction between Van Dijk's (2020) four access types suggests that policies restricted to equipment distribution tend to produce limited outcomes unless accompanied by equivalent investment in teacher and student education. This need is corroborated by ICT in Education 2024 data discussed earlier, revealing a mismatch between widespread tool adoption by students and pedagogical guidance actually received (NIC.BR, 2025b). The same survey recorded use by 58% of secondary school teachers, compared with 43% among teachers across all educational stages surveyed (NIC.BR, 2025b). In parallel, Cetic.br's sectoral study identified demand for education, institutional guidelines and better infrastructure, especially in public education (NIC.BR, 2025a). Third, the heterogeneity of benefits described in accessibility literature (CHEMNAD; OTHMAN, 2024) indicates that

policies for students with disabilities must consider different educational needs rather than treating artificial intelligence as a generic solution.

A practical development of this recommendation involves designing teacher education programs that go beyond presenting the features of specific tools, quickly superseded by new versions, to develop teachers' conceptual understanding of how generative artificial intelligence systems produce responses, their reliability limits and how to integrate them into teaching activities with pedagogical intent. Such programs, aligned with the artificial intelligence literacy concept discussed earlier (LONG; MAGERKO, 2020; NG et al., 2021), tend to produce more lasting effects than one-off training centered on specific tools, although their relative effectiveness across Brazilian education systems remains, like the other hypotheses in this essay, a subject for future empirical investigation.

This evidence strengthens the theoretical diagnosis but does not eliminate the need for new studies. Future empirical research should measure, in specific Brazilian education systems and schools, how income, territory, infrastructure, education and institutional design interact in producing educational benefits and risks associated with artificial intelligence.

One final point deserves mention in this section: interpretation of the national data used throughout this essay should consider that successive editions of the same sample survey may present methodological variations, recommending caution in directly comparing specific percentages between nonconsecutive years. This qualification does not invalidate the general patterns discussed here, which remain consistent across different survey editions, but cautions against any hasty reading of the data as strictly linear indicators of progress or regression in Brazilian digital inclusion.

4. Final considerations

The analysis indicates that artificial intelligence can expand access to information, support learning and encourage social participation, but this potential is not realized automatically. Its effects depend on interconnected conditions of material access, competencies, pedagogical mediation, institutional infrastructure and ethical regulation. Table 1 synthesizes these conditions and offers a reading matrix distinguishing the technological object, levels of access and outcomes, mediation, infrastructure, and requirements of regulation and cognitive justice.

When these conditions are insufficient, there is a theoretically grounded risk of reproducing or intensifying social, educational and territorial inequalities. This risk is an

analytical hypothesis rather than an empirically demonstrated conclusion: the Brazilian data employed document differences in connectivity, use, guidance and education, but do not by themselves prove differences in learning or cognitive benefit. The transition from adoption to outcomes must be investigated using specific measures and designs.

The challenge for educational policies therefore extends beyond making tools available. It requires connectivity and devices, teacher and student education, institutional contracting criteria, data protection, accessibility standards, linguistic diversity, human oversight and participation of affected groups. From this perspective, the analytical framework can support institutional diagnoses and public policy by making the questions and indicators of each dimension explicit, preventing availability, use and outcomes from being treated as equivalent.

Without claiming to exhaust the subject, the essay proposes a research agenda capable of testing the relationships synthesized in Table 1. Quantitative studies can combine access and use indicators with pre- and post-intervention measures in delimited educational tasks; qualitative approaches can examine how students and teachers interpret, verify and negotiate everyday artificial intelligence use. Comparative designs across education systems, educational stages and student profiles can also assess how income, territory, accessibility, infrastructure, education and governance interact in producing benefits and risks. Collaboration between education, computer science and applied social sciences is necessary to transform this agenda into knowledge useful for formulating Brazilian educational policies.

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