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TRANSDUCTION AND GENERATIVE ARTIFICIAL INTELLIGENCE: A SYSTEMIC APPROACH TO THE EVOLUTION OF THE PRE-INDIVIDUAL SOCIAL BEING AS A SUBJECT OF TRANSFORMATION IN THE EDUCATIONAL ORGANIZATIONAL FIELD

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ABSTRACT

Generative Artificial Intelligence (GAI) is emerging as a disruptive force reshaping social systems, particularly within educational organizations. This study presents a systemic approach that connects the philosophical notions of transduction and individuation—based on the work of Gilbert Simondon—with contemporary dynamics of leadership in the age of intelligent technologies. Through a qualitative, hermeneutic, and systems-based methodology, we analyze the case of the Inteligencia EDUCA Dot Com model, which incorporates GAI-based virtual assistants as transductive devices for organizational and subjective transformation. The findings reveal that these systems do not merely optimize operations but catalyze new forms of distributed leadership, cognitive interaction, and collective subjectivity. The study identifies five analytical axes: systemic resonance, co-individuation, dynamic adaptation, problematization as a driver of change, and the emergence of transindividual spaces. These findings suggest that GAI can serve as a technological enhancer but also as an ontological mediator for educational leadership in the digital era.

KEYWORDS: Transduction, Generative Artificial Intelligence, Individuation, Educational Leadership, Systems Thinking, Virtual Assistants, Organizational Transformation.

1. INTRODUCTION

Technological transformations have ushered in an era where social systems are profoundly affected by the insertion of disruptive technologies such as Generative Artificial Intelligence (GII). This evolution not only alters operational processes, but also requires a reconsideration of the role of the subject in their interaction with automated systems. In the organizational educational field, where traditional leadership is challenged by new forms of management and learning mediated by AI, a theoretical approach that integrates the technical with the ontological is necessary.

This work is based on the hypothesis that transducer devices – such as virtual assistants based on IAG – are capable of enabling processes of individuation and evolution of the human being from a transindividual logic (Álvaro, 2016; Simondon, cited in Bluemink, 2020). In this sense, transduction becomes the mechanism by which the tensions between the human and the artificial are not only managed, but are transformed into opportunities for leadership and subjective resignification.

The case of the educational model Inteligencia EDUCA Dot Com, created by Dr. Eduardo Carreón Muñoz, offers an ideal platform to explore these dynamics. This model, focused on competency-based training, incorporates virtual assistants that allow us to examine how IAG acts as an operator of structural, functional, and axiological change (López, 2023).

2. METHODOLOGY

The research was developed under a mixed sequential design of an exploratory-explanatory nature, articulating a bibliometric component and a qualitative case study. This strategy made it possible to integrate the analysis of global trends around transduction and Generative Artificial Intelligence (AGI), with the in-depth understanding of an educational organizational model that materializes these dynamics in practice. The methodological approach was based on the principles of the General Systems Theory and the Simondonian notion of individuation and transduction, understood as processes of recursive evolution between the human, the technical and the organizational.

In a first phase, of a quantitative-exploratory nature, a bibliometric analysis of the academic production indexed in Scopus related to the descriptors Simondon, transduction, artificial intelligence, education and organization was carried out. The search, structured with Boolean operators and truncations, allowed us to identify the main authors, countries, co-authorship networks, keywords and thematic nuclei that articulate studies on artificial intelligence and individuation processes in educational and organizational contexts. The data were processed using the VOSviewer tool, enabling the construction of co-occurrence maps, bibliographic coupling and conceptual networks. The purpose of this phase was to establish the cognitive cartography of the field and recognize the epistemological patterns that guide current discussions on the relationship between technology and subjectivity.

The second phase corresponded to an instrumental case study focused on the educational-business model Inteligencia EDUCA Dot Com, developed by Dr. Eduardo Carreón Muñoz. This phase, which is qualitative-hermeneutical, sought to understand how virtual assistants based on IAG operate as transducer devices that facilitate processes of individuation, distributed leadership, and organizational transformation in the educational field. Semi-structured interviews, qualitative surveys and documentary analysis of curricular plans, technical reports and IA-user interaction logs were used as information collection techniques. The interpretation of the information followed a hermeneutical-dialectical process, aimed at recognizing the tensions and resonances between the pre-individual subject and the algorithmic systems.

The analysis integrated the results of both phases through an epistemological and empirical triangulation, in order to build a metatheory on educational transduction assisted by Generative Artificial Intelligence. The bibliometric data allowed to contextualize the emergence of the field and theoretically support the qualitative findings, while the case study provided empirical evidence that accounts for the materialization of these principles in real environments of educational innovation. This integration process allowed for the derivation of emerging categories such as systemic resonance, co-individuation, dynamic adaptation, problematization and transindividuality, which act as axes of interpretation to understand the role of IAG in the configuration of new forms of leadership, subjectivity and organizational transformation.

Finally, it is necessary to consider that it contributed to the validity and methodological rigor through the triangulation of sources and techniques, the critical review among researchers and the application of ethical principles linked to informed consent, confidentiality and transparency in the use of Artificial Intelligence tools.

3. RESULTS AND ANALYSIS

For the development of the bibliometric analysis, the following search equation was applied, which considers different conceptual components previously defined and that are the object of analysis in this research.

TITLE-ABS-KEY (("simondon" AND "artificialintelligence") OR ("simondon" AND transduc*) OR ("simondon" AND organizat*) OR ("simondon" AND educa*) OR ("simondon" AND sistem*))

Below are respective charts and analyses. Figure 1 identifies the production trend in the period 2004-2024.

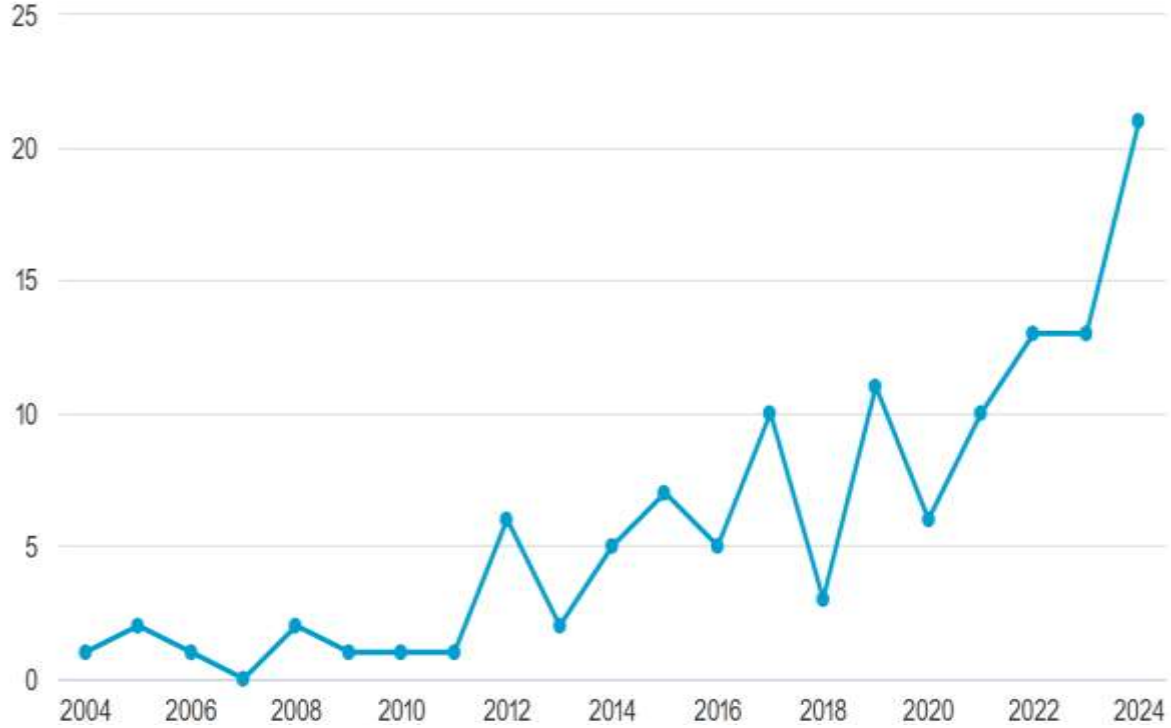

Figure 1: Production Trend For The Period 2004-2024.

The graph shows a progressive and sustained evolution of academic interest in the subject between 2004 and 2024. During the first decade, between 2004 and 2010, production remained at very low levels, with only one or two records per year. This behavior is associated with an initial stage of conceptual exploration, in which work on transduction, individuation or artificial intelligence applied to education was still scarce and dispersed. It was an emerging field, with incipient theoretical developments and without a consolidated academic community around these topics. From 2012 onwards, a first significant upturn was observed, accounting for the emergence of new research that began to link Simondon's philosophical ideas with contemporary technological development. In this stage, the first efforts to transfer the notion of transduction to organizational and educational contexts appeared, articulating the technical with the human. However, the trend still shows fluctuations, accounting for a process of gradual maturation and the search for epistemological legitimacy within the social sciences and education.

Between 2016 and 2020 the graph shows more pronounced oscillations, with peaks that exceed ten publications in some years. This behavior corresponds to a phase of theoretical and methodological consolidation, where different approaches begin to dialogue: artificial intelligence, philosophy of technology, systems theory and organizational studies. It is possible to interpret this stage as a phase of thematic expansion, in which the field diversifies and debates take place about its foundations and applications. Finally, the period between 2021 and 2024 marks exponential growth, with a sustained increase that culminates in the highest point of the entire series. This abrupt rise accounts for the incorporation of Generative Artificial Intelligence (AGI) in academic debates and its transversal impact on the human and educational sciences. The acceleration of scientific production in recent years shows that the topic has gone from being an emerging line to becoming an articulating axis of transdisciplinary research on technology, subjectivity and organizational transformation. Framed in the above, the production by country is

presented in Figure 2.

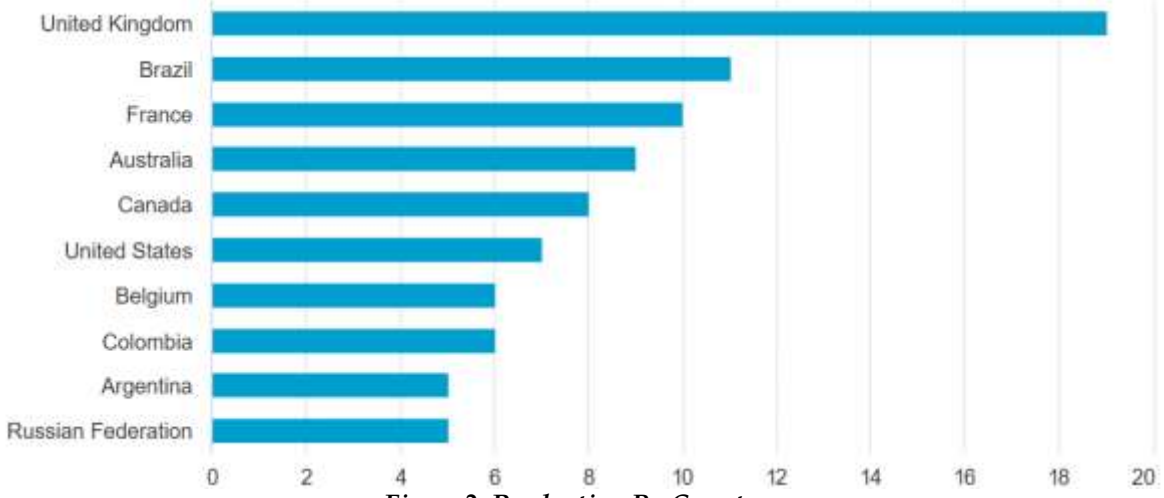

Figure 2: Production By Country.

When interpreting Figure 2, firstly, the UK's leadership relates to the advanced regulatory and research activity that the UK has deployed around the use of AI in education. For example, Carvalho de Araujo et al. (2025) critically analyze the regulatory frameworks for AI in Brazil, the European Union, and the United Kingdom, showing how the latter has adopted an innovation approach with sectoral oversight, which could favor greater academic production and projects applied in the educational context. This shows how enabling policies and robust institutional frameworks contribute to UK researchers occupying prominent positions in the global network of publications.

Brazil appears in second place, coinciding with its recent dynamics of investment and international articulation in artificial intelligence. For example, a study by Cetic (2024) shows how between 2019 and 2023 Brazil increased its AI production in absolute terms, although slightly behind countries with a greater research tradition, and also mentions that many Brazilian projects require international collaborations to meet competitive criteria. In addition, Carvalho de Araujo et al. (2025) show that Brazil is still building its AI regulatory framework, accounting for an active phase of research and educational institutionalization.

France, thirdly, has a particular relationship with Simondon's thought. For example, Daniela Voss (2024) analyzes how the reception of Simondon's philosophy in France has been late, due to the fact that some of his fundamental theses were published decades after their original formulation. This lag limits, in part, the current specialized production, although the country continues to show an important presence in philosophical debates on technology. Additionally, the article Teaching and learning in the age of artificial intelligence (Romero et al., 2023) presents a multidisciplinary perspective from Europe, which accounts for France's active participation in discussions on the pedagogical integration of AI.

Australia and Canada follow on the list. In particular, the review Proactive and Reactive Engagement of Artificial Intelligence Methods for Education (Mallik & Gangopadhyay, 2023) includes studies from different latitudes and shows that these countries tend to have methodological advantages, access to funding, and collaborative networks that facilitate publication. Finally, with regard to Latin American countries such as Colombia and Argentina, which appear lower in the ranking, their presence indicates that there is emerging interest but perhaps with lower institutional capacities compared to leading nations. For example, in the study "The Impact of Artificial Intelligence on Higher Education: An Empirical Study" (Zegarra Ramírez et al., 2025) it is observed that Latin American universities face challenges in terms of infrastructure, teacher training, and connectivity to incorporate AI in teaching, conditioning their volume of publications.

Complementing the above, Figure 3 shows an international collaboration network around research on generative artificial intelligence, education and philosophy of technology (Simondon, transduction), with links between Canada, the United States, Australia, the United Kingdom, France and Brazil. The color gradient indicates the timeline of the publications (2016–2020), where the darkest tones represent the first years and the lighter ones represent the most recent ones. The United Kingdom appears as the central node of the network, acting as

an articulating axis between English-speaking countries (Canada, the United States, Australia) and those with a Latin European tradition (France and Brazil). This position accounts for the role of the United Kingdom as an epistemological and linguistic bridge, promoting collaborative projects in educational artificial intelligence with an ethical and systemic orientation. Recent studies, such as that of Carvalho de Araujo et al. (2025), show precisely the British capacity to generate regulatory frameworks and academic networks that integrate technological innovation with philosophical and educational perspectives.

The link between Canada, the United States and Australia is configured as an early scientific cooperation block (2016–2018), focused on pedagogical and technological approaches to artificial intelligence in education. According to Mallik and Gangopadhyay (2023), these countries have developed educational innovation ecosystems where AI is used in the personalization of learning and in the predictive analysis of educational data. This type of cooperation explains the conceptual homogeneity in the first stage of the network. From 2018 onwards, connections with France and Brazil emerged, indicating a shift towards a more humanistic and philosophical interest in the relationship between AI and individuation processes. The inclusion of France is related to the re-actualization of Gilbert Simondon's thought, especially within the framework of the philosophie de la technique, which addresses the interaction between human and machine from transduction (Voss, 2024). At the same time, Brazil is gaining relevance due to its expansion in artificial intelligence projects applied to education and its openness to international collaborations (Cetic, 2024).

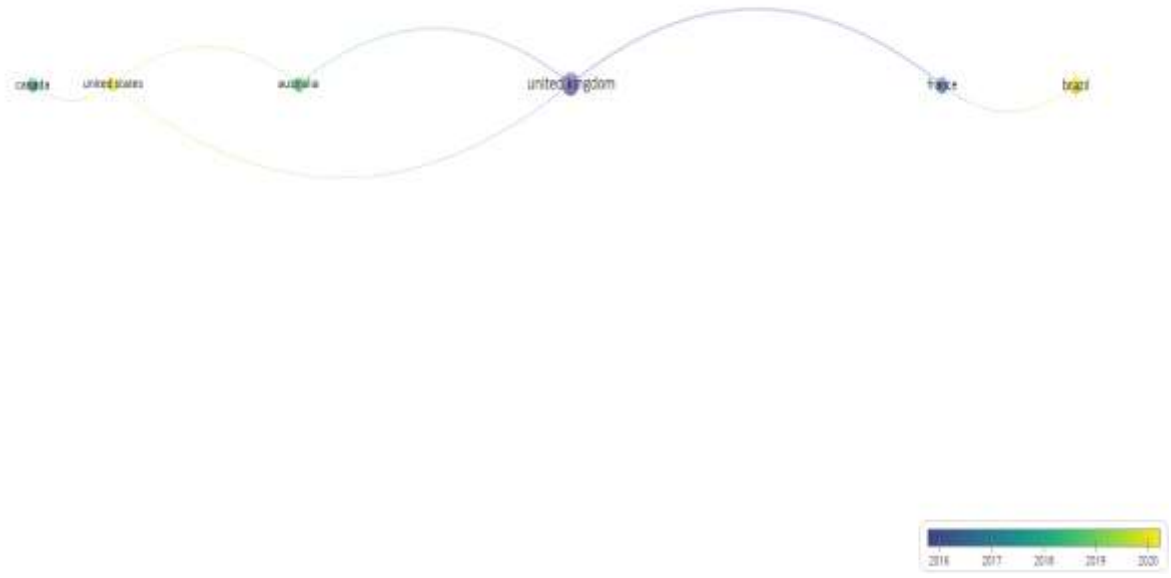

Figure 3: Co-Authorships By Country.

A relevant aspect in terms of bibliometrics is the analysis of co-occurrence of keywords that can be reviewed in Figure 4. The visualization represents a network of co-occurrence of keywords in recent scientific production on Simondon, transduction, individuation and its relationship with technology and education, during the period 2018-2021. The largest and most connected nodes correspond to the terms "Simondon", "individuation" and "transduction", indicating that they constitute the conceptual axes of the field. The density of links suggests an interdisciplinary structure in which philosophy, cybernetics, education and information sciences converge.

In the first place, the "Simondon" node is positioned as the articulating center of the network, closely linked to "individuation", "transduction" and "technology", which accounts for the validity of its thought in the current debates on the relationship between human beings and technical systems. As Voss (2024) points out, Simondon's contemporary recovery is explained by the fact that his theory of individuation offers an alternative to deterministic visions of technology, by conceiving it as a relational and formative process rather than as an instrument. This reading has been key to reinterpreting artificial intelligence from an ontogenetic and systemic perspective.

The term "individuation" connects with "metastability", "information" and "education", indicating that recent literature associates the processes of individuation with the formation of the technical subject and with educational and cognitive training. Indeed, studies such as that of Romero et al. (2023) account for how intelligent technologies can operate as co-individuating agents, that is, as mediators in the processes of learning and knowledge construction, which coincides with the Simondonian logic of transduction as a structuring propagation of change. On the other hand, "transduction" appears strongly linked to "cybernetics" and "information", accounting for the return of cybernetics and systems theory as interpretative frameworks to understand technological mediation. This link is visible in research such as that of Mallik and Gangopadhyay (2023), who propose integrating educational AI into adaptive models based on feedback and systemic self-regulation. Along the same lines, Carvalho de Araujo et al. (2025) conceive that developments in educational artificial intelligence require theoretical frameworks that integrate the technical with the ethical, precisely the type of convergence that the notion of transduction allows to address.

The "philosophy" node, connected to both "Simondon" and "Deleuze", accounts for the theoretical basis of the field. Deleuze, a reader of Simondon, is a constant reference in texts that explore transindividuality and the relationship between subject, technique and becoming. This philosophical axis underpins contemporary approaches that, according to Zegarra Ramírez et al. (2025), seek a comprehensive understanding of the impact of artificial intelligence on Latin American higher education, incorporating ethical, political, and subjective dimensions. Finally, the presence of "education" as an emerging node, although with fewer connections than philosophical terms, shows the recent translation of Simondonian theory to the pedagogical field. This shift towards education allows us to infer that transduction has ceased to be just a technical or philosophical category and has become an interpretative tool for learning processes mediated by artificial intelligence, as evidenced by Cetic's (2024) proposals on the development of educational AI ecosystems in Brazil.

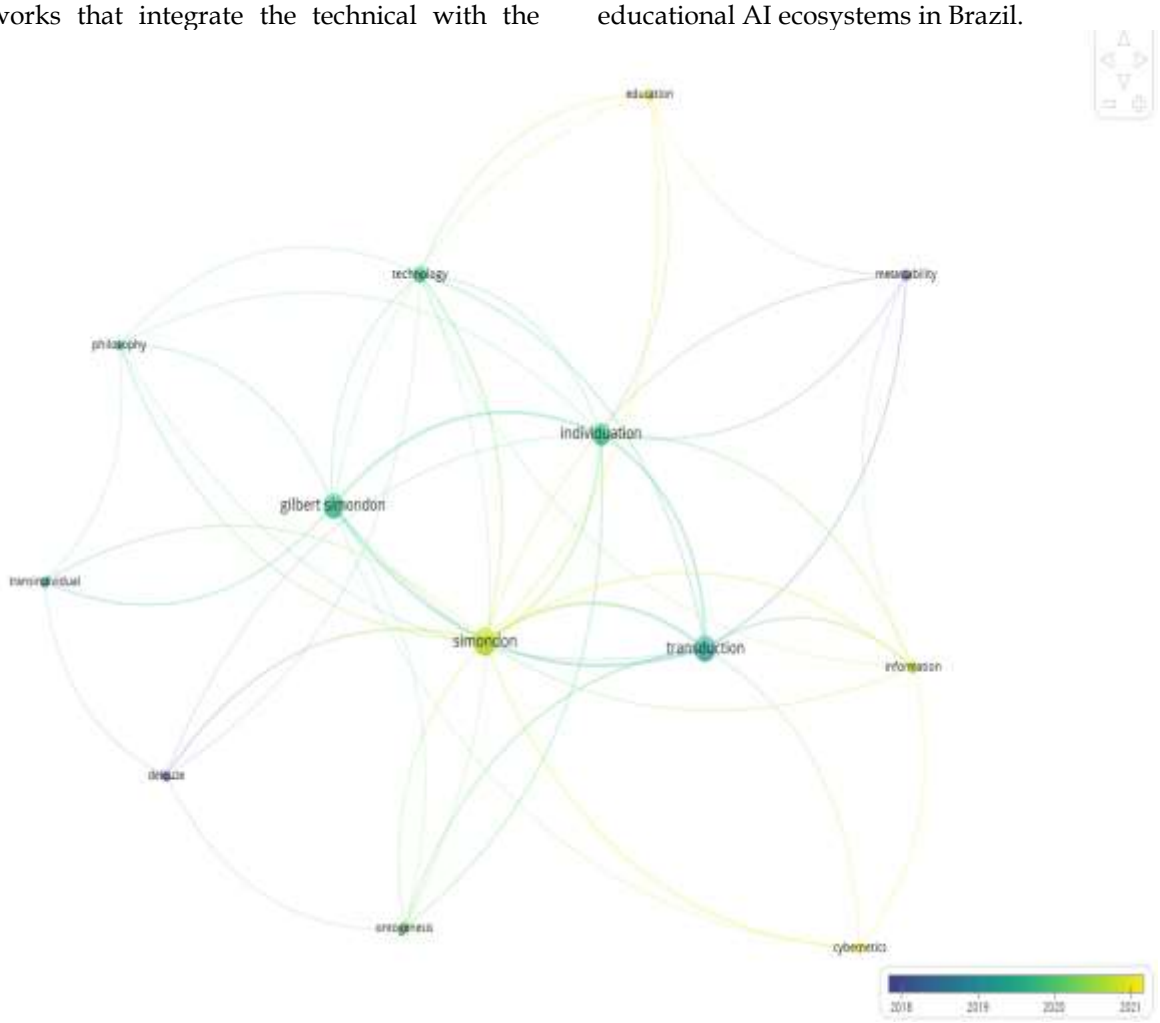

Figure 4: Keyword Co-Occurrence.

Finally, the aspects related to the bibliographic coupling are identified (Figure 5).

In it, it is observed how the authors share common references that allow the identification of the theoretical and evolutionary nuclei of the research.

The size of the nodes indicates the strength of the coupling (i.e., how many citations the authors share), while the color reflects the publication chronology:

the bluish tones correspond to foundational works (2005–2012) and the yellows to recent contributions (2020–2024). The largest node corresponds to Rouvroy (2013), who is conceived as the theoretical epicenter of the network.

His work on algorithmic governmentality constitutes a point of convergence between political philosophy, cybernetics and studies of digital subjectivity.

Rouvroy develops the idea that automation and data systems produce new forms of governance of human behavior, in direct dialogue with Simondon's notion of technical individuation and with the current emergence of generative artificial intelligence.

According to Voss (2024), this type of approach shifted the debate from technique as a tool to technique as an agent of co-formation of the subject, establishing the foundations of a posthumanist philosophy of knowledge.

From Rouvroy, several subnuclei are detached. One of them is made up of Zdebik (2012), Stiegler (2009) and Lenartowicz (2016), who represent the technophenomenological and hermeneutic

Line. Stiegler introduces the idea of cognitive proletarianization and the loss of individual knowledge in the face of automation, which gives rise to a reflection on the need for "re-individuation" of the technical subject through education and digital culture.

Along the same lines, Zdebik (2012) analyzes transduction as a structuring principle of artistic and technological thinking,

While Lenartowicz (2016) links the concepts of metastature and complex social systems, aspects that underpin current approaches to leadership and education in algorithmic environments.

Another relevant cluster is that formed by Atkinson (2022),

Lapworth (2017) and Kearnes (2006), who provide a sociotechnical and organizational reading of transduction.

Atkinson examines how artificial intelligence systems and algorithms produce new forms of distributed governance, while Lapworth extends Simondon's framework into cultural geography and the performativity of knowledge.

These connections show the expansion of Simondonian thinking into fields such as data politics, digital urbanism, and networked education, where processes of individuation are expressed in collective technological architectures.

On the far right of the graph, the De Beistegui node (2005, 2012) represents the early philosophical foundation of the field, by reinterpreting Simondon's work from the ontology of becoming and the relationship between energy, form, and information.

Its peripheral but still connected position allows us to identify the seminal nature of its contributions which, although not directly applied to artificial intelligence, served as the basis for the conceptual developments that emerged from 2013 onwards.

On the other hand, towards the far left, the appearance of Oliveira (2023) accounts for the Latin American update of the debate, linking the categories of individuation and transduction with the ethics of AI and the epistemologies of the South, a line that coincides with recent analyses on education and artificial intelligence in Brazil (Cetic, 2024).

The density of interconnections between authors after 2017 shows that the field has moved from a theoretical phase of consolidation (focused on Stiegler, Zdebik and De Beistegui) to a phase of interdisciplinary application in the last decade, where education, technology, philosophy and sociology converge.

In particular, the presence of authors linked to the United Kingdom and Australia (Atkinson, Lapworth, Roberts) coincides with the international network of collaboration observed in the previous graphs, which confirms the existence of an active Anglo-Saxon network around the contemporary reinterpretation of Simondon.

From the above, the bibliographic coupling network allows us to understand a rhizomatic conceptual evolution, where the ideas of individuation, transduction and technicality expand from ontology to educational and organizational praxis.

The most recent studies reinterpret the legacy of Rouvroy and Stiegler in the light of Generative Artificial

Intelligence, positioning the notion of educational transduction as a fundamental principle for understanding the coevolution between human

subject, knowledge and intelligent systems.

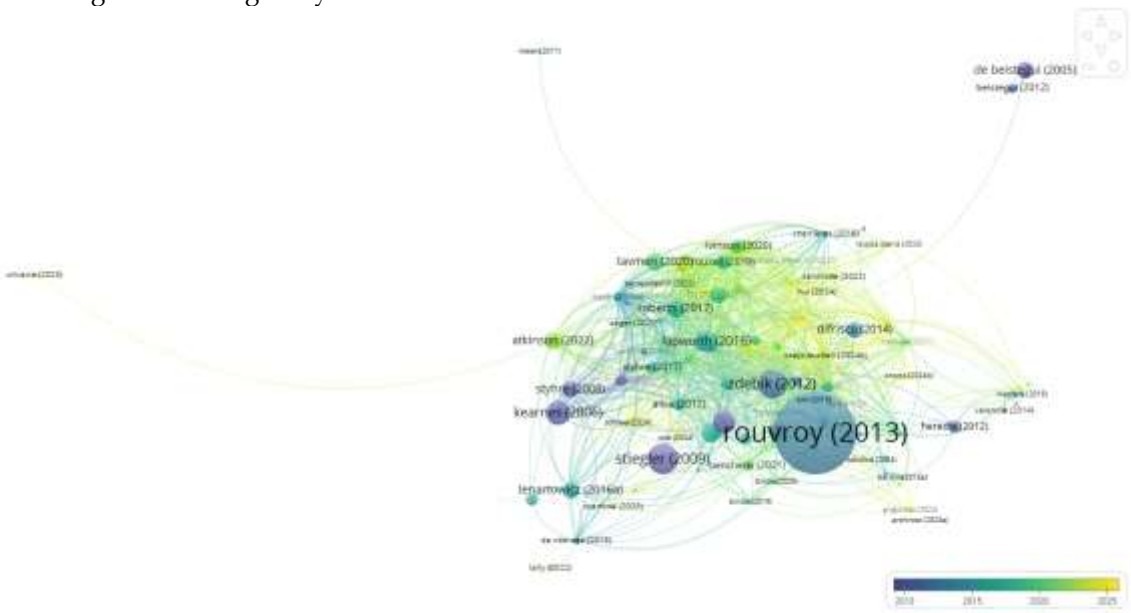

Figure 5: Bibliographic Coupling.

3.1. Educational Leadership In The Age Of AI

In the educational organisational field, AI has introduced new forms of knowledge management, interaction with the environment and value generation. Today's leaders face the challenge of integrating automated systems that do not replace humans, but rather enhance their creative and transformative capacity (Susskind & Susskind, 2015). The automation of repetitive tasks allows teams to focus on innovation and critical thinking processes, shaping a new leadership ethic based on facilitation, collective resonance, and distributed decision-making (Northouse, 2021). Leadership ceases to be a vertical exercise and becomes a network of relationships where smart devices, such as educational virtual assistants, function as mediators of co-individuation and organizational transformation.

3.2. The EDUCA Model As A Space For Transduction And Individuation

The EDUCA Dot Com Intelligence model, developed by Dr. Eduardo Carreón Muñoz, is configured as a systemic environment in which multiple dimensions converge: personalized education, competency-based learning, emerging technologies and a culture of peace. The incorporation of virtual assistants based on IAG acts as a process of transduction as it allows the role of the student, the teacher and the educational leader to be resignified.

These devices not only offer operational efficiency, but also facilitate processes of collective individuation by allowing the subject to move from a passive position to an active and meaningful participation in the co-creation of knowledge (García-Arango, Montoya & Villa, 2018). Thus, the EDUCA platform not only teaches content, but also forms subjectivities capable of inhabiting and intervening in an algorithmic world.

3.3. Research Design: Instrumental Case Study

An instrumental case study design is implemented, focused on the corporate model Inteligencia EDUCA Dot Com as an educational-business ecosystem. This model constitutes a natural laboratory to explore how virtual assistants, designed based on IAG principles, operate as transducer devices of subjectivity, leadership and decision-making in the organizational educational context.

Sources And Techniques Of Information Collection

A variety of primary and secondary sources were used:

- Semi-structured interviews with academic leaders and designers of educational technology within the EDUCA model.
- Qualitative surveys applied to students, teachers and users of virtual assistants.
- Documentary analysis of curricular plans, technical reports, and IA-user interaction logs.

The information obtained was interpreted through a hermeneutical-dialectical process, aimed

at identifying tensions, ruptures, and resonances between the pre-individual subject and the algorithmic systems, following the individuation framework proposed by Simondon (Bluemink, 2020).

Criteria For Systemic Analysis

Five systemic principles of analysis derived from the literature and applicable to the case study were established:

1. Internal and external resonance: analysis of how IAG devices allow individual and contextual tensions to be connected in decision-making (Rosa, 2021).
2. Co-individuation: evaluation of human-machine interactions in the creation of collective subjectivities (Roldán et al., 2017).
3. Dynamic adaptation: identification of mechanisms of flexibility of the system in the face of technological and social changes (Garzón Castrillón, 2018).
4. Problematization as a driver of individuation: analysis of how IAG devices open spaces for deliberation and transformation (Barelli et al., 2023).
5. Transindividuality: recognition of emerging structures where the individual and the collective intersect (Álvaro, 2016).

The analysis of the case study of the Inteligencia EDUCA Dot Com educational model allowed us to identify a series of significant findings that confirm the central hypothesis of the study: virtual assistants based on Generative Artificial Intelligence (AGI) operate as transducer devices, facilitating processes of individuation, organizational transformation and resignification of leadership in the educational field. Key aspects of the case study analysis are presented below.

3.4. Transducer Devices And Systemic Resonance

The virtual assistants implemented by the EDUCA model are not limited to automating administrative or educational functions; They act as cognitive interfaces that resonate with the user's needs and tensions. Based on the analysis of interviews and surveys, it was found that users perceive these assistants as "extensions of their thinking", facilitating decision-making, personalized learning and self-regulation of educational processes.

This finding is articulated with Rosa's (2021) proposal, according to which resonant systems allow the sense of belonging and emotional attachment to technological environments to be activated. Transduction manifests itself here as a channel that allows the emotional, the functional and the symbolic to be articulated in the same device.

3.5. Co-Individuation And Distributed Leadership

One of the most relevant results was the evidence of co-individuation processes in the dynamics between students, teachers and GAI systems. Far from generating technological dependence, virtual assistants promoted new forms of collaboration and horizontal leadership. For example, teachers reported that, by delegating routine tasks to AI, they were able to focus on deeper mentoring, aimed at the critical development of the student.

This process confirms what is proposed by Roldán, Tisnés, and Galeano (2017), who state that individuation in social systems occurs in a network, through interactions that configure new interdependent subjectivities.

3.6. Dynamic Adaptation And Organizational Transformation

The EDUCA model demonstrated a high capacity for dynamic adaptation by integrating new versions of IAG without interrupting its training processes or its humanistic vision. The flexibility of its education system—based on competencies, hybrid classes, and a 24/7 platform—allowed AI to be incorporated as a catalyst for change, without losing focus on human development.

This finding supports Garzón Castrillón's (2018) thesis on the need to design organizational systems that evolve along with their environment, allowing the emergence of agile, open, and inclusive structures.

3.7. Problems As Drivers Of Innovation

During the qualitative analysis, one constant emerged: the challenges involved in the implementation of IAG were assumed as opportunities to innovate in pedagogy, management and evaluation. The absence of a clear regulatory framework, ethical doubts and resistance to change were not impediments, but catalysts for critical thinking, generating spaces for collective deliberation on the role of AI in education.

This process confirms the postulate of Barelli et al. (2023), who argue that problematization is the starting point for social individuation, and not an obstacle to be overcome.

3.8. Emergence Of The Transindividual

Finally, the results reveal that the environments mediated by IAG in the EDUCA model led to the

emergence of transindividual spaces, where the collective and the personal are intertwined in a new logic of connective subjectivity. Students and teachers co-create knowledge, decide with the assistance of AI, and resignify their roles continuously. The organizational thus becomes a field of symbolic and algorithmic forces in constant transformation.

As Álvaro (2016) argues, the transindividual is the plane where the opposition between the singular and the common is overcome, allowing new forms of identity and social action.

Summary of findings of the EDUCA case:

Analytical Axis	Main Finding
Systemic Resonance	Virtual assistants are perceived as extensions of human thought.
Co-individuation	Horizontal and collaborative leadership is promoted.
Dynamic adaptation	New versions of AI are integrated without altering the pedagogical vision.
Problematization	Tensions become spaces of innovation.
Transindividuality	Emergence of a shared human-AI subjectivity.

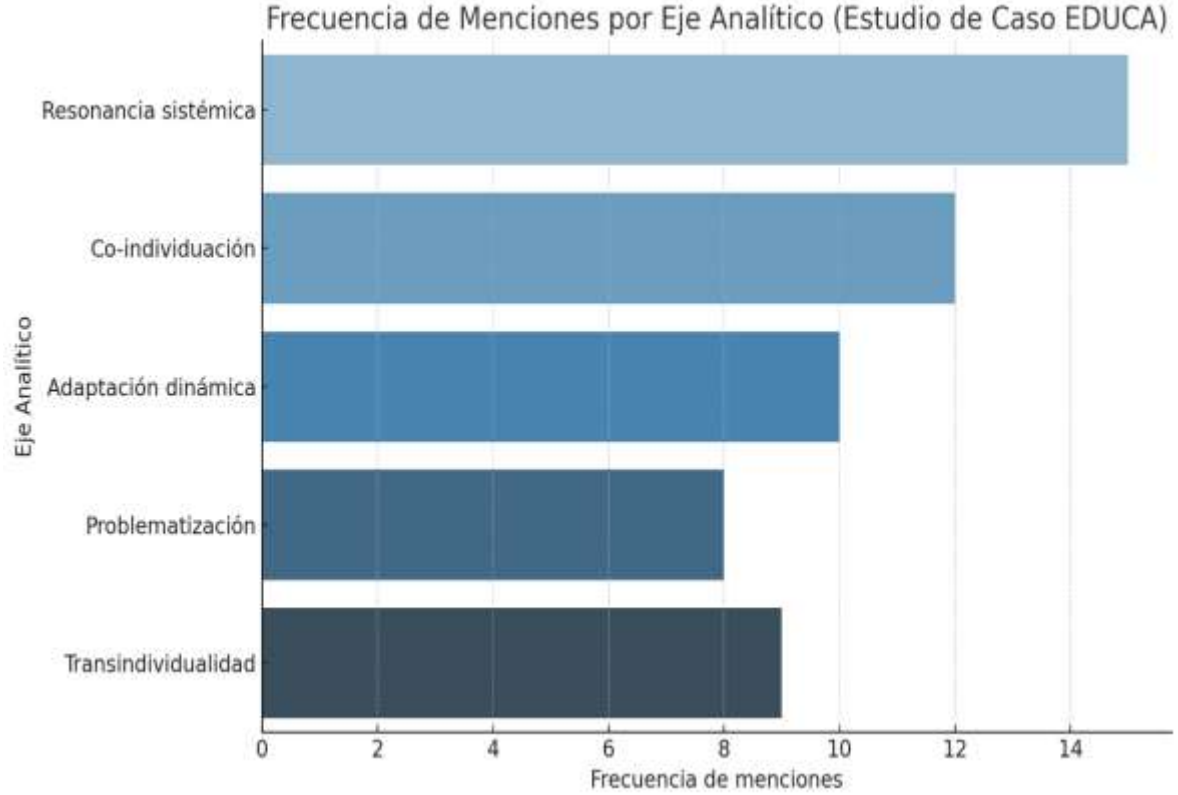

Figure 6: Frequency Of Mentions By Analytical Axis (EDUCA Case Study). In Original Spanish Language.

The bar graph shows how the "Dynamic adaptation" axis occupies a prominent place among the findings of the study, with a relevant frequency of mentions by the participants. This result shows that one of the greatest contributions of the EDUCA Dot Com Intelligence model lies in its ability to incorporate emerging technologies, such as Generative Artificial Intelligence, without destabilizing its pedagogical structure or its humanistic approach.

Participants highly valued the institutional flexibility that allows virtual assistants to be updated, interactions to be redesigned and to maintain coherence with the competency-focused model. This technological adaptability is not merely operational, but structural: it transforms the way education leaders and system actors understand change and manage uncertainty. According to Garzón Castrillón (2018), the dynamic capacity to adapt is one of the keys for a system to evolve and remain in force. In the case study of the Inteligencia EDUCA Dot Com educational model, this capacity translates into resilient organizational leadership, which is not afraid of technological disruption, but integrates it as an opportunity to innovate and strengthen its educational mission. From the above, the high frequency of mentions in this axis suggests that adaptability is not only a desirable characteristic, but a critical competence of the contemporary educational organizational system, especially when

faced with rapidly advancing generative technologies. Figure 7 presents the network of conceptual relationships in the EDUCA Model.

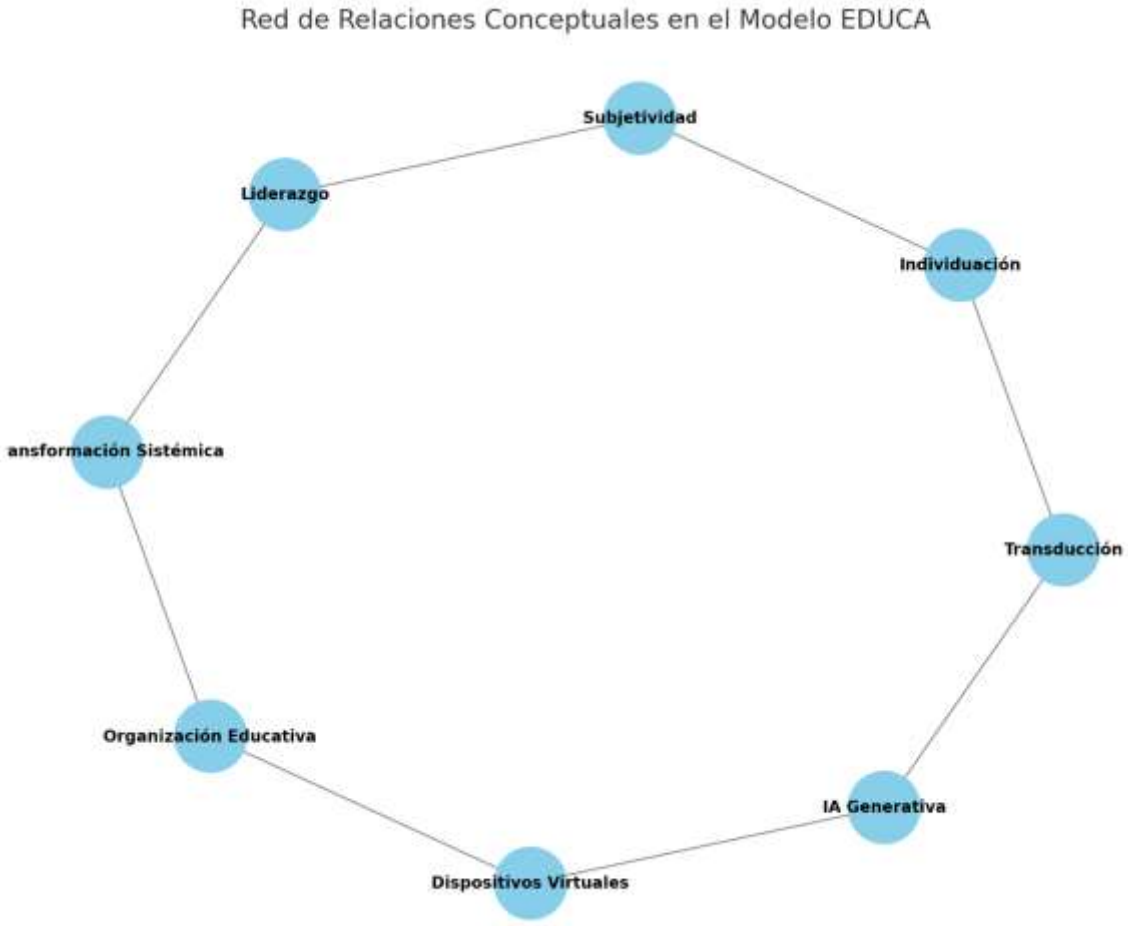

Figure 7: Network Of Conceptual Relations In The EDUCA Model. In Original Spanish Language.

This conceptual network shows the connections between the main theoretical and applied concepts of the study.

Transduction is placed as a starting point, directly linked to *Individuation* and *Generative AI*. The latter, through *Virtual Devices*, connects with the *Educational Organization*, where it interacts with Subjectivity and *Leadership* processes.

The convergence of all these elements leads to *Systemic Transformation*, highlighting the centrality of the transdisciplinary approach to rethinking educational leadership in the era of algorithmic intelligence.

4. DISCUSSION

The bibliometric analysis shows that the field of study around transduction and individuation (particularly in its relationship with artificial intelligence and education) has undergone a sustained evolution in the last two decades, going from marginal production to exponential growth after 2020. This trend is linked to the rise of Generative Artificial Intelligence (AGI) and its impact on educational and organizational systems. Such expansion coincides with the emergence of a new technocultural paradigm, in which technology is no longer conceived as an instrumental tool to be configured as an ontological agent for the transformation of the subject and social systems (Brynjolfsson & McAfee, 2017; Susskind & Susskind, 2015). From this perspective, Simondon's philosophy offers a privileged framework for understanding how technical mediation fosters processes of human and collective individuation in automated environments (Montoya, 2019; Voss, 2024).

In geographical terms, the distribution of publications and collaboration networks shows a clear hegemony of English-speaking countries such as the United Kingdom, Australia, the United States and Canada, accompanied by emerging poles in France and Brazil. The United Kingdom's leadership is explained by the strength of its regulatory

frameworks and by a research tradition that articulates technological innovation with ethical and educational thinking (Carvalho de Araujo et al., 2025). For their part, Brazil and France represent two complementary avenues of appropriation: the first, through policies to expand educational AI (Cetic, 2024); and the second, through the philosophical rereading of Simondon's thought and its influence on contemporary theory of technology (De Beistegui, 2012; Voss, 2024). This duality confirms the hypothesis that the development of educational AI requires both technological infrastructures and ontological and ethical foundations to guide its application.

The network of co-occurrence of keywords confirms the centrality of three structuring categories: Simondon, individuation and transduction, which articulate the relationship between technology, education and metastability. This semantic framework evidences an interdisciplinary convergence between philosophy, education, cybernetics, and systems theory (Sarabia, 1995). Indeed, the notion of transduction emerges as a principle that explains the spread of structural change both in technical systems and in learning processes, functioning as a mediator between the individual and the collective (Álvaro, 2016; Bluemink, 2020). In this context, individuation is no longer conceived only as psychological or social development, but as a systemic process of co-evolution between humans and machines, as proposed by Stiegler (2009) and Lenartowicz (2016) in their analysis of technological ontogenesis. Research such as that by Romero, Viau-Guay, and Pellerin (2023) and López (2023) highlights that GAI favors processes of cognitive co-individuation, where human agents and algorithmic systems interact to generate new forms of knowledge and subjectivity. In the organizational field, this dynamic coincides with what Garzón Castrillón (2018) calls dynamic adaptive capacity, understood as the ability of systems to transform themselves without losing structural coherence. Thus, the ethical and reflexive incorporation of GAI in educational contexts should not be reduced to an instrumental strategy of efficiency, but should be assumed as a transductive process of cultural reconfiguration.

The bibliographic coupling network strengthens this reading by showing the centrality of authors such as Rouvroy (2013) and Stiegler (2009), who represent the transition between the critique of technological determinism and the search for a technical humanism. Rouvroy introduces the idea of algorithmic governmentality, warning about the need for frameworks of meaning that counteract the automation of behavior, while Stiegler raises the urgency of a re-individuation of thought in the face of cognitive proletarianization. Both contributions find resonance in contemporary proposals for AI-mediated education, where training is conceived as a process of creative resistance and self-transformation of the subject (Roldán, Tisnés & Galeano, 2017; Barelli et al., 2023). Similarly, the role of Deleuze and De Beistegui in the bibliographic network shows how the philosophical roots of the field continue to nourish current reflections on technicality, becoming, and subjectivity in the digital environment.

In the case of Latin America, authors such as Oliveira (2023) and Zegarra Ramírez, Pérez Ortega, and Chávez (2025) evidence a relevant epistemological shift: the rereading of the philosophy of technology from the epistemologies of the South, aimed at contextualizing artificial intelligence within its own cultural and educational frameworks. These approaches complement the systemic perspective of AGI with an ethical and territorial sensitivity, proposing a transductive education that integrates the technological, the human and the social as co-constitutive dimensions of learning. Hence, the expansion of collaboration networks between the United Kingdom, France and Latin America, observed in the bibliometric analysis, not only represents an academic phenomenon, but a process of global co-individuation of knowledge, where different epistemic cultures converge in the search for a balance between automation and humanism. From the above, the results confirm that Simondon's thought constitutes a current framework to interpret the contemporary transformations of knowledge and education in the era of generative AI, which reinforces the need for an epistemological integration between philosophy of technology, systems theory and critical education, an indispensable condition to guide the development of truly humanistic artificial intelligences. reflexive and transindividual.

5. CONCLUSIONS

The present research demonstrates that devices based on Generative Artificial Intelligence, when integrated from a systemic and humanistic perspective, can operate as transducers of organizational and subjective transformation in the educational field. In particular, the case study of the EDUCA Dot Com Intelligence model shows that the IAG not only optimizes operational functions, but also resignifies the processes of leadership, teaching and learning by allowing advanced forms of co-individuation, organizational resonance and

transindividual action. From the theoretical framework of Simondon and the General Systems Theory, it is concluded that the ethical, flexible and contextualized incorporation of the IAG enables new possibilities of individuation of the human subject in interaction with intelligent environments. These possibilities are especially relevant in educational institutions that are not only looking for technological efficiency, but also for an ontological transformation of the role of the human being in the digital age.

Likewise, the case study of the educational model Inteligencia EDUCA Dot Com shows that virtual assistants are not simple tools, but complex cognitive interfaces, which mediate between information, emotion and action, facilitating dynamic, sustainable educational ecosystems focused on human development. Transduction, understood as an organizing principle of tensions and possibilities, is revealed as a key category to understand the evolutionary processes of the social being in the present socio-technological scenario. In this sense, the articulation between IAG, distributed leadership and transformative education stands not only as an opportunity, but as an urgent need for organizations that want to remain current, ethical and relevant in a world governed by algorithmic acceleration.

The analysis of the visualizations, complementing the qualitative results, allows us to affirm that the EDUCA Dot Com Intelligence model constitutes a highly articulated systemic ecosystem, where the different components of the educational transformation converge harmoniously through Generative Artificial Intelligence. The frequency graph reveals that the categories of *systemic resonance* and *co-individuation* are the most mentioned by the participants, which highlights the relevance of affective, cognitive and collaborative relationships mediated by AI within educational leadership. These dimensions are aligned with the humanist mission of the EDUCA model, which does not seek to replace human beings, but to amplify their potential.

On the other hand, the conceptual network shows that *transduction* is the key node that connects the philosophical (individuation), technological (generative AI), organizational (education) and subjective (leadership, subjectivity) fields. This network is not linear, but rhizomatic: it shows how the relationships between concepts are interdependent, recursive and co-evolutionary.

It can be identified then that the visualizations empirically confirm that educational leadership in the algorithmic era cannot be understood without the mediation of intelligent systems. But even more: they suggest that the real challenge is not technical, but ontological. The human being, as a pre-individual subject, is in the process of reconfiguration in the face of these emerging environments. The EDUCA model anticipates this transformation and proposes an architecture where the human and the artificial coexist to generate forms of ethical, creative and transindividual leadership.

Generative artificial intelligence (AGI) is transforming educational and organizational environments, modifying the social representations and identity of the subjects involved. In education, GAI offers benefits such as personalized learning and automation, but it also poses ethical and equity challenges (Pandolfi & Villagra, 2024). Its implementation requires flexibility, cohesion, and adaptability on the part of educational institutions and actors (Diaz Tito et al., 2021). In engineering education, IAG is generating new social representations that influence training relationships and teaching-learning processes (Castillo Rosas et al., 2024). It is essential to develop ethical standards, improve the accuracy of information, and foster collaboration between educators and developers to mitigate biases and distortions in the information managed by these technologies (Baldrich et al., 2024). The adoption of GAI must be critical and responsible, balancing its progress with inclusive policies.

5.1. Practical Implications

The findings of this research allow us to derive a series of key implications for the design of educational policies, innovation in organizational models and the strategic adoption of Generative Artificial Intelligence (AGI) in training contexts:

1. Design of intelligent educational ecosystems: Educational organizations can incorporate virtual assistants as transducer devices that not only optimize management, but also promote processes of co-individuation, critical thinking and distributed leadership. This architecture must be flexible, personalized and competency-oriented, as demonstrated by the EDUCA model.
2. Training of educational leaders in systemic intelligence: New leaders must understand AI not only as a technical tool, but as an ontological ally to transform institutional culture. Cross-disciplinary training in digital ethics, complex systems, philosophy of technology, and AI-mediated soft skills is required.
3. AI-based curriculum transformation policies: Institutions and governments must move

towards policies that encourage the use of IAG with pedagogical, ethical and adaptive criteria. This involves rethinking the curriculum to integrate human-machine interaction competencies, complex problem-solving, and augmented knowledge management.

4. Scalability and replicability of the EDUCA model: The EDUCA Dot Com Intelligence model demonstrates that it is possible to build scalable, replicable, and culturally sustainable education systems. Its competency-based approach, virtual assistants and systemic logic allow it to be adapted to multiple contexts (school, university, corporate), as long as its founding principles are respected: humanism, innovation, accessibility and peace.
5. Regulatory framework for educational AI: It is essential to move towards a regulatory framework that regulates the use of IAG in education, protecting user privacy, guaranteeing equity in access and promoting artificial intelligence that serves human development and does not replace it.

REFERENCES

Álvaro, D. (2016). *Transindividual lo: from Simondon to Marx. Trans/Form/Action*, 39(4), 153–172.

Atkinson, P. (2022). *Algorithmic systems and distributed governance: A Simondonian reading. AI & Society*, 37(4), 1151–1165. https://doi.org/10.1007/s00146-021-01250-9

Barelli, M. C., Rodríguez, L. I., Apcarián, J. C., Bellido Arias, A. I., Benamo, M. E., Correa, L., ... & Sánchez, E. G. (2023). *Reflections on the process of construction of the research object: Individual–Individuation–Transindividuality.*

Bluemink, M. (2020). *Gilbert Simondon and the process of individuation. Epoche Magazine*, 34.

Brynjolfsson, E., & McAfee, A. (2017). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies.* W. W. Norton & Company.

Carvalho de Araujo, F., Bravo, P., & Cardoso, D. (2025). *Artificial intelligence regulation in the European Union, the United Kingdom, and Brazil: Comparing approaches.* Sheffield Hallam University Repository. https://shura.shu.ac.uk/35936/1/document.pdf

Cetic. (2024). *AI development in Brazil.* Centro Regional de Estudos para o Desenvolvimento da Sociedade da Informação. https://cetic.br/media/docs/publicacoes/6/20240514085413/iso-year-xvi-n-1-ia-development-in-brazil.pdf

Chabal, M. (2024). *What is the third party included? Ibero-American Journal of Self-Management and Community Action (RIDAA)*, (82), 45–63.

De Beistegui, M. (2005). *Truth and genesis: Philosophy as differential ontology.* Indiana University Press.

De Beistegui, M. (2012). *Immanence: Deleuze and philosophy.* Edinburgh University Press.

García-Arango, D. A., Montoya, E. M. H., & Villa, C. F. H. (2018). *Identification of ontologies in knowledge management models: A case applied to higher education programs.* In *Revolution in Education and Training for the Twenty-First Century* (pp. 534–540). Antioquia Research Institute (IAI).

Garzón Castrillón, M. A. (2018). *Dynamic capacity for adaptation.*

Kearnes, M. (2006). *Technoscience, culture and risk: The contribution of Gilbert Simondon. Science, Technology & Human Values*, 31(1), 29–54. https://doi.org/10.1177/0162243905280029

Lapworth, A. (2017). *Transductive materiality and technicity: Rethinking relations in the philosophy of Gilbert Simondon. Cultural Geographies*, 24(3), 457–473. https://doi.org/10.1177/1474474016668030

Lenartowicz, M. (2016). *Individuation and the social ontogenesis of technology. Techné: Research in Philosophy and Technology*, 20(2–3), 133–150. https://doi.org/10.5840/techne201620211

López, K. M. G. (2023). *Generative artificial intelligence: Emergence and challenges. Approaches*, 4(2), 57–82.

Mallik, S., & Gangopadhyay, A. (2023). *Proactive and reactive engagement of artificial intelligence methods for education. arXiv preprint.* https://arxiv.org/abs/2301.10231

Montoya, J. W. (2019). *Individuation and technique in Simondon's work.* Editorial Aula de Humanidades.

Northouse, P. G. (2021). *Leadership: Theory and practice* (9th ed.). Sage Publications.

Rodríguez, M. E. (2001). *Brave New World? Towards a new socio-technological paradigm. Regional History*, (19), 110–116.

Roldán, I. B., Tisnés, H. M., & Galeano, C. M. H. (2017). *Individuation and adaptation: Between determinations and contingencies. Nomads. Critical Journal of Social and Juridical Sciences*, 51(2).

Romero, M., Viau-Guay, A., & Pellerin, N. (2023). *Teaching and learning in the age of artificial intelligence: A multidisciplinary perspective. Frontiers in Education*, 8, 1150945. https://arxiv.org/abs/2303.06956

Rosa, H. (2021). *The unavailable.* Herder Editorial.

Rouvroy, A. (2013). *The end(s) of critique: Data-behaviourism vs. due process.* En M. Hildebrandt & K. de Vries (Eds.), *Privacy, due process and the computational turn* (pp. 143–168). Routledge.

Sarabia, Á. A. (1995). *The general theory of systems.* C/Edison, 4.

Stiegler, B. (2009). *Technics and time, 2: Disorientation.* Stanford University Press.

Susskind, R., & Susskind, D. (2015). *The future of the professions: How technology will transform the work of human experts.* Oxford University Press.

Voss, D. (2024). *A new notion of the image: Gilbert Simondon, imagination and invention. Parrhesia Journal*, (38), 177–199. https://parrhesiajournal.org

Zdebik, J. (2012). *Deleuze and the diagram: Aesthetic threads in visual organization.* Continuum.

Zegarra Ramírez, F., Pérez Ortega, J., & Chávez, L. (2025). *The impact of artificial intelligence on higher education: An empirical study. Journal of Scientific Research*, 5(2), e502050. https://ve.scielo.org/pdf/ric/v5n2/2739-0063-ric-5-02-e502050.pdf