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Article

Epistemology, Paradigms of Knowledge, and Connectivism: Networks, Distributed Cognition, and the Extended Mind from the Perspective of Teachers' Digital Competencies

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RESUMEN

El artículo analiza la idea de *conectivismo* planteada por George Siemens (2004). Postulado como paradigma epistemológico, la dinámica filosófica implicada ha reconfigurado velozmente las formas de producción, circulación y validación del conocimiento en la era digital. Al analizar e interpretar el artículo seminal *Connectivism: A Learning Theory for the Digital Age*, se derivan y examinan de su estructura seis dimensiones: epistemológica, ontológica, tecnológica, pedagógica, organizacional y axiológica, incorporándose diálogos con aportes provenientes de epistemologías pedagógicas, filosofías de la tecnología y pedagogías complejas. Como metodología, el estudio adopta un enfoque interpretativo de carácter hermenéutico-analítico, soportado en el análisis de literatura especializada y en la articulación conceptual con otras investigaciones sobre competencias digitales docentes. Los resultados interpretativos permiten sostener que el conectivismo no se limita a una teoría de aprendizaje, sino que constituye una nueva racionalidad epistémica, basada en la adquisición de conocimiento mediante *cognición distribuida*, *aprendizaje en red* y *extensión tecnológica de la mente*. Se discuten los principales desafíos pedagógicos, éticos y organizacionales que esta visión paradigmática plantea, destacándose la redefinición del rol docente, los criterios de calidad educativa junto con los procesos de formación en competencias digitales. Se concluye que el conectivismo como paradigma ofrece un marco interpretativo apropiado para comprender los procesos formativos en la era digital, por lo que, comprendido en todas sus dimensiones, garantizaría reflexividad contextual, justicia epistémica y responsabilidad ética, como componentes del acto educativo en la era digital.

Keywords: conectivismo, epistemología pedagógica, educación superior, cognición distribuida, competencias digitales.

ABSTRACT

The article analyzes the idea of connectivism postulated by George Siemens (2004). Interpreted as an epistemological paradigm, its dynamics have rapidly reconfigured the forms of production, circulation, and validation of knowledge. Based on a review and interpretation of the seminal article *"Connectivism: A Learning Theory for the Digital Age*," the epistemological, ontological, technological, pedagogical, organizational, and axiological dimensions of connectivism are deduced and examined, incorporating dialogues with contributions from pedagogical epistemologies, philosophies of technology, and complex pedagogies. As a methodology, the study adopts an interpretive approach of a hermeneutical-analytical nature, supported by the analysis of specialized literature and conceptual articulation with other research on digital teaching competencies. The results allow us to argue that connectivism is not limited to a theory of learning, but constitutes a new epistemic rationality, based on the acquisition of knowledge through distributed cognition, network learning, and the technological extension of the human mind. The main pedagogical, ethical, and organizational challenges posed by this paradigmatic vision are discussed, highlighting the redefinition of the teaching role, the criteria for educational quality, and the processes of training in digital competencies. It is concluded that connectivism as a paradigm offers an appropriate interpretive framework for understanding educational processes in the digital age, which guarantees reflexivity, epistemic justice, and ethical responsibility as components of all educational acts.

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Keywords: connectivism, pedagogical epistemology, higher education, distributed cognition, digital competencies.

Introduction

Higher education is currently navigating paths that lead toward an unprecedented structural transformation; driven this time by the expansion of digital technologies—which are propelled exponentially by artificial intelligence—it is the result of the consolidation of a society organized into networks of information and knowledge, which is referred to in these times by the neologism "digital society"[1] (Polo, 2020; Villalobos, 2023; Alamo, 2024).

The discussions emerging in the context of digital disruption call into question the legitimacy of knowledge as well as the validity of the procedures that underpin it; this has led to a shift in the logic of understanding fostered by classical explanatory theories of reality, which, due to these very circumstances, are now the subject of serious epistemological controversies[2] .

In this context, the traditional pedagogical and epistemological models discussed by Siemens (behaviorism, cognitivism, and constructivism[3]) reveal—precisely because of these circumstances, which of course challenge their very foundations—significant limitations in explaining how knowledge is produced, validated, and mobilized in environments shaped by complex digital structures, which are in turn characterized by their dynamism and rapid pace of transformation (Díaz, 2024; Sánchez et al., 2024).

In light of the challenges posed by computational technologies, new theories are emerging that explain the reality of knowledge and learning; these arise precisely from the contexts of digital society[4] ; such theories foster an understanding of the phenomenon of interconnection from a networked perspective[5] . One of these theories is called "connectivist," or simply "connectivism," formulated by George Siemens in 2004, emerging as an explanation for the profound transformation of educational ecosystems brought about by computer networks themselves, as explained in this paper.

More than a simple theory of learning, connectivism proposes a radical reconfiguration of knowledge, understanding that it no longer resides exclusively in the human mind, but rather that its formation and generation are *distributed* across networks composed of knowledge nodes created around this framework, consisting of both human and non-human entities. This phenomenon can be characterized thanks to other phenomena that in turn make it possible: these are primarily so-called "big data," the highly controversial

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1 Because of this way of organizing itself, society has been called a "digital society." See the arguments in Villalobos (2023), which justify the use of this term. Information and communication networks, by virtue of technological developments, are referred to, in the same vein, as "digital networks," which have major implications for higher education, as posited here.

2 For a discussion of the paradigm shifts arising from the clash of epistemological perspectives, see: Martínez et al. (2026). This work addresses a specific aspect that warrants close attention: the consequences that followed the famous 1969 Urbana Symposium, where the foundations of science in the last quarter of the 20th century were thoroughly debated.

3 It is against these three epistemic models or paradigms that Siemens constructs the theory of connectivist learning (Siemens, 2004).

4 This "digital society" is also referred to in a narrower sense as an "actor-network" by Bruno Latour (2008), to denote the intervention of the concept of human networks in contexts of uncertainty and social interconnection—not in the sense of machines, but from a human perspective, considering the objects with which people interact: the human tendency to form social networks of family, friends, and other relational ties, to which are added "things" that are the objects of relationships or that mediate them. However, to understand the nature of digital society in the context of the internet, see: Castells (2019). For a review of the implications of connectivism at a general level, see the special issue of the journal IRRODL, edited by Siemens & Conole (2011).

5 See Villalobos (2025) for some aspects of this theory of knowledge and the dimensions in which connectivism has been delineated as an epistemological conception, within the framework of the paradigm discussed here. See also the challenges of knowledge in the age of AI in: Naranjo et al. (2026).

"computational algorithms," the "digital platforms" that are highly useful in the analyzed context, and finally the perplexing "virtual communities," as Bustos and Martín (2024) also note.

All of the above elements contribute to the dimensions delineated in this work, thus forming the conceptual framework from which the epistemological perspective underpinning connectivism as a theory is explained—a matter viewed not only as a theory of learning[6] , but also, most importantly for our philosophical and pedagogical position, as a theory of knowledge; ultimately, it concerns the epistemological foundation.

From this perspective, learning has ceased to be a process centered on the internalization of stable content—as is typically the case with traditional epistemic knowledge (Hessen, 2006[7] ; Martínez, 2024; Martínez et al., 2021)—and has instead become a practice of connecting, navigating, updating, and critically selecting information online; this is valued as the new path along which society is moving, mediated by new technologies, which also facilitate *online learning*[8] ; ultimately, it concerns the new conceptions of reality in which knowledge resides in networks[9] .

The principle guiding this epistemic perspective will no longer be centered on "knowing what," nor on "knowing how," which are traditional in learning theories, according to Siemens (2004). However, these two aspects of knowledge are not dismissed as constitutive elements; rather, the "why"[10] is added to them, cutting across them; from the perspective of connectivism, the novelty centers on "knowing where," referring to what Siemens (2004) and Siemens and Conole (2011) call *" "* or *knowing how to find*, thereby defining itself as a new and important form that knowledge takes in order to be attained and fundamentally appropriated[11] .

Evidently, this challenges classical epistemological foundations, raising crucial questions about the nature of knowledge, and—more importantly in the pedagogical sphere—the nature or foundations of learning, which necessarily intersects with the role of the knowing subject and the function of innovative knowledge education. From this vantage point, the focus is on university education permeated by the digital age, a sphere within which the act of knowledge is particularly situated in these times of technological revolution and the digital society (Villalobos, 2023; Bermeo et al., 2025; Reguero and Pérez, 2025).

In the present era, we are navigating a period of social transformations resulting from the severe changes brought about by new technologies (Costa, 2021; Costa, 2024; Rodríguez, 2024; Abanades and Vargas, 2025). Consequently, the transformations occurring within the reproductive framework of the social order take on

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6 See Campos (2012) for some reconstructive references to this theory of learning.

7 It is important to note that this traditional perspective has been extensively revisited by the history of epistemology and the theory of knowledge. For a perspective based on current critiques of the traditional view of knowledge, see: Salamanca (2023), Vaz de Campos et al. (2024), Martínez et al. (2026), Morin (1999), Capra (1992), among others.

8 For a philosophical analysis of the significance of new digital technologies represented by artificial intelligence, see: Bermeo et al. (2024). However, for a critical perspective on online learning, see: Kop (2011).

9 See the epistemic nature of knowledge generated in Artificial Intelligence contexts in: Bermeo et al. (2025). For a conception of knowledge from emerging and transformative epistemologies, see: Villalobos et al. (2022b).

10 The ethics of knowledge and the responsibility that permeates it are increasingly in demand in light of the evident consequences of new techno-scientific developments, especially those related to new technologies, the most prominent of which are those enabling artificial intelligence (AI). For a comprehensive review of this techno-scientific development and its consequences in certain fields of knowledge, see: Crawford (2023).

11 Heuristics plays a role of significant importance in this regard; thus, this conception of knowledge—which is not novel in a general sense, as the History of Philosophy attests—presents a new dimension that makes this knowledge a very special facet of the history of knowledge and epistemology. A new path has begun to be charted based on these knowledge strategies and their epistemological foundations, as one of the authors of this work has been developing (Villalobos, 2018, 2023, and 2025).

particular relevance in the field of university pedagogy, where, since the mid-20th century, educational quality has been increasingly linked to the development of teachers' digital competencies (Lozano and Olmedo, 2021; Villalobos et al., 2022a; Villalobos, 2023; Calvo et al., 2024; Espinoza and Alcaide, 2024).

In this context, these are not merely technical skills but are understood as profound epistemic, pedagogical, ethical, and indeed critical abilities for acting in environments of permanent connectivity—the essential characteristic of the new pedagogical environments fostered by digital technologies[12] .

Within the theoretical, philosophical, and social framework described, this article aims to analyze George Siemens's connectivism as an epistemological paradigm, exploring its constituent dimensions and its implications for contemporary pedagogy. The research question guiding this study can be formulated as follows: To what extent does connectivism redefine the epistemological foundations of knowledge, and what challenges does it pose for the training and performance of university faculty in digital learning contexts?

The objective of this work is, therefore, to conduct a philosophical examination of the epistemological foundations of connectivism considered as a paradigm of knowledge and, consequently, as a paradigm of learning. The article brings the postulates of connectivism into dialogue with approaches such as distributed cognition, the extended mind, and network theory, as well as with current debates on educational quality and teachers' digital competencies. In this way, this article seeks to contribute to the academic discussion on the new paradigms of knowledge permeating higher education and to offer some conceptual keys for rethinking university pedagogical practice in the digital society.

Methodology

This study adopts a philosophical hermeneutic approach, grounded in a critical and dialogical perspective (Gadamer, 1993), whose purpose is to understand and interpret certain categories derived from George Siemens's (2004), considered an epistemological paradigm, which is thought to have emerged in light of the rapid and clearly expanding developments of digital networks in university education. The study is, therefore, an exploration of the conceptual and categorical hermeneutic horizon of connectivism in an epistemological sense, aimed at clarifying its foundations, scope, and the tensions that arise between it and pedagogy practiced in university contexts, within the framework of digital teaching competencies.

Type of study: The research falls within the field of philosophical-hermeneutic and pedagogical studies, supported by research based on both bibliographic and periodical documents and texts, centered on the study and analysis of the theorists involved in the research, recently published scientific and philosophical articles, and some relevant documents and texts. The central focus of the analysis is the seminal article "*Connectivism: A Learning Theory for the Digital* Age" by George Siemens (2004), complementing the analysis with contributions from contemporary epistemology, the philosophy of technology, digital pedagogy, complexity theory, and finally studies on distributed cognition and digital competencies.

Theoretical corpus: The analyzed corpus is structured into three levels of sources: 1. Primary source: Siemens, G. (2004), as the foundational text of connectivism. 2. Complementary theoretical sources: Distributed cognition and the extended mind (Hutchins, 1995; Clark and Chalmers, 2011). Relational and post-foundationalist epistemologies (Latour, 2008; Villalobos et al., 2022b; Villalobos, 2023; Bedoya, 2025). Complex

[12] In global contexts, and particularly in Latin America (Ecuador, Spain, Chile, Colombia, Mexico, and Argentina), national agencies in these countries have emphasized the urgency of strengthening these competencies as a prerequisite for ensuring high-quality, inclusive, and relevant educational processes in higher education (Leal, 2011; Centeno and Cubo, 2013; Viñoles et al., 2022; Córdoba et al., 2024).

thought and socioformation (Morin, 1999; Tobón, 2005 and 2013). 3. Contextual and other sources: Research on teachers' digital competencies in higher education and other documents.

Hermeneutic procedure: The analysis was conducted through a categorical and dimensional reading of connectivism, identifying six dimensions of the theory: the epistemological, ontological, technological, pedagogical, organizational, and axiological dimensions. Each of these was examined in terms of its conceptual foundation, its educational implications, and its critical tensions in relation to university pedagogy.

This procedure made it possible to construct a philosophical and theoretical interpretation grounded in connectivism as an epistemological framework—rather than merely as a teaching technique or methodological approach—and thus constitutes an attempt to carry out a hermeneutic interpretation to shed light on this emerging phenomenon, given the implications of its application in the field of education in particular, but also in the context of emerging social phenomena in general[13] . The concept of hermeneutics should also be understood here in the Gadamerian sense, that is, assuming that hermeneutic action points toward the horizon of interpretation in which the interpreter is also a creator of meaning of the interpreted object (Gadamer, 1993).

This is the case in the present study; interpretation is approached from a stance of understanding the reality under study based on the authors' own philosophical and empirical references within their context, granting the act of interpretation true conceptual autonomy and, consequently, creative legitimacy: the act of interpretation is also creation (Gadamer, 1993; Habermas, 1996; Grondin, 2002; Heidegger, 2021)[14] .

Results and Discussion

Epistemological Dimension: Connectivism as an Emerging Epistemological Paradigm

In line with the methodology outlined above, the first result of the analysis in this study allows us to affirm that connectivism transcends the status of a learning theory, thus establishing itself as an epistemological paradigm, as it redefines, through its heuristic strategy, the nature of knowledge and its acquisition in the digital age. From this perspective, knowledge is no longer understood as a stable mental representation but is conceived as a flow of networked content—a process that is inherently dynamic and relational, configured by nodes of knowledge—and is thus continuously updated through interconnections that reinforce the digital network; it is both cause and effect, forming a complex recursive movement. In this way, knowledge is seen more as a strategic process than as substantive content characteristic of traditional epistemologies.

This conception shifts the classical focus from the traditional, individual, particular knowing subject toward an emerging subject practicing a relational epistemology, in which knowledge no longer emerges solely from human cerebral interaction; it arises from the often uncontrolled interaction between humans, technologies,

[13] It is important to note that connectivism, as an emerging social phenomenon, has impacted all spheres of human activity and all age groups, especially in the contexts of children, adolescents, young adults, and older adults—the latter being an area where extensive studies have been conducted focusing on social or structural support (Paiva et al., 2025), on good living (Paiva et al., 2026), and where attempts are now being made to address this in a special way, shifting the analysis toward the impact of connectivism on the relational lifeworld of these older adults, with an ambitious project underway on technological appropriation.

[14] A hermeneutic practice carried out under the parameters of hermeneutic phenomenology by the authors of this work is evident in the study on the hermeneutics of the pedagogical act in: Villalobos et al. (2024).

and information systems[15] . This shift engages with post-foundationalist epistemologies[16] and with actor-network theory (Latour, 2008; Brito et al., 2025), the latter of which posits that the objects of human interaction also possess agency: they conceive of knowledge as the effect of heterogeneous, open-ended connections of individual origin.

In this dynamic sense, knowledge is no longer mere representation; rather, it is established as a networked system of relationships connecting the different computational nodes within which it is structured (Paniagua et al., 2024; Braza, 2026). At the epistemic core of this theory lies the fact th , knowledge is no longer based on the mere understanding of a substance, property, or relationship; knowledge and its appropriation as learning are, in essence, a network of links that is updated based on the interaction among the nodes that constitute the computational system; it is, in short, a procedural, dynamic, fluid, and reticular perspective.

According to the above, each interconnection node in the network is in turn a point of exchange but also a generator of knowledge[17] , constituting an infinite multidimensionality of knowledge-generating nodes in open interaction, often undetected by users integrated into the network; that is to say, to the computational system, thus forming the aforementioned reticular structure; although it must be stated with certainty that the human and non-human actors of the system are integral to the systemic formation of the network, that is, the fact that it is composed of both humans and non-humans is what is meant in a novel sense in this conception, both epistemologically, as discussed in this section, and ontologically, as discussed in the following section (Siemens, 2004; Siemens and Conole, 2011; Villalobos et al., 2023b).

However, despite this systemic novelty, the epistemological shift thus constituted raises a *fundamental tension*: the risk of reducing knowledge to mere navigable information, thereby undermining the processes of critical validation and meaningful appropriation necessary for the epistemological validation of knowledge. This notion of navigable information implies a new dimension of knowledge and, likewise, a new learning strategy, as the act of knowing shifts toward "knowing how to navigate" through knowledge networks to attain, precisely, knowledge, but also to learn to navigate in contexts of uncertainty, not only in an ethical sense but also in an onto-epistemological sense, as discussed in the following section (González and Ortiz, 2025).

From this perspective, a new tension arises due to the uncertainty caused by the fluidity of networks and the liquidity of the context (Latour, 2008; Bauman, 2018; Villalobos et al., 2023b): uncritically adopted connectivism can lead to an epistemology of the fluidity of knowledge that is paradoxically lacking in foundations, which not only problematizes but also undermines the idea of the substance to which all knowledge refers[18] . Hence, this paradigm of knowledge gains relevance for higher education, the privileged sphere of knowledge generation in modern society (Bauman, 2018 and 2020; Rabelo and Aleida, 2024;), where it is also reaffirmed as a learning paradigm.

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[15] The idea of uncontrolled interaction to attain knowledge is precisely the focus of attention surrounding this paradigm. An epistemological conception provides the foundation and decisive control over the knowledge to be acquired through reflection on the reality under study. See García (2000).

[16] See: Gastón (2023); Juárez (2024); Juncolà (2025), among others. These epistemologies refer to the idea of knowledge that is not centered on unquestionable fixed points, since the being, as the subject of knowledge, and knowledge, as the object of knowledge, are no longer self-contained; that is, unquestionably definitive: they are always subject to changes in their foundations, given that they can always be refuted, rearticulated, redefined, rethought, or redesigned (Popper, 1980; Martínez, 2016; Kuhn, 2021).

[17] This is the idea behind structural networks and actor-network theory (Latour, 2008).

[18] This is based on the idea that anyone who seeks knowledge is prone to errors in their understanding of reality (Gabriel, 2024), especially in the digital context, where we are far more susceptible to deception and illusion than in other contexts of the lifeworld (Serrano, 2016). This becomes most evident with the emergence of AI in educational contexts. For a perspective on epistemology in this field, see: Bermeo et al., (2024); Bermeo et al. (2025).

The epistemological dimension of connectivism clearly weaves into the fabric of contemporary philosophy the idea that networked knowledge is validated by the concept of "knowing how to search," thereby complementing "knowing how to know" (Weber and Provenza, 2025; Burgos et al. 2025), thereby introducing a new dimension to the structure of knowledge, an issue emphasized in this work.

To summarize the above, and as an approach to the interpretive framework of the subject of study in this research, it can be stated that connectivism is emerging as an epistemological paradigm, whose postulates are displacing the classical criteria of knowledge validity—centered on individual-subjective internalization, conceptual stability, and disciplinary authority, to orient itself toward a relational logical e —through the connection between the network's knowledge nodes—that is dynamic and, ultimately, distributed (across all the knowledge nodes that comprise it); in this context, knowing is equivalent to *knowing how to establish*, *maintain*, and *evaluate* the connections that meaningfully form within networks of humans and *machines*, while constantly evaluating the production of knowledge.

Thus, from Siemens's (2004) perspective, the epistemic value of knowledge no longer lies primarily in its accumulation, much less in its internal coherence, but—something absent in classical epistemologies—in its capacity for circulation, its speed of updating, and its ability to operate within highly complex information systems, which are characterized by uncertainty (in complex systems), the speed of obsolescence (given their rapid reproduction), and—something novel in epistemic practices—informational overabundance.

This, of course, is not without its objections, especially in light of the new conceptions of reality that have emerged in recent years, which impact the argument regarding the digital society[19] . Hence, the reality of connectivism fosters a tendency toward chaos, incoherence, and disorder that manifests itself through the nodes of the network, which decisively contributes to the logical possibilities of the formation of false knowledge. For this reason, the axiological dimension is highlighted in the following section.

In accordance with the above, connectivity stands as a central criterion of validation: knowledge is relevant to the extent that it allows access to relevant nodes—whether human or non-human—and the recognition of emerging patterns (something essential in complex systems), so that system users can ultimately make informed decisions "in real time."

The reconceptualization carried out in these terms of knowledge circulation not only redefines what it means to "know" in the digital age, but also challenges the epistemological foundations of traditional pedagogy, by situating learning beyond the individual (subjective) mind and understanding it as a distributed, situated, and technologically mediated phenomenon, thereby opening a new horizon characterized by its coherence with the ontological and cognitive conditions of the network society, which is discussed below.

Ontological dimension: relational ontology and distributed cognition in the connectivist paradigm.

This is another dimension derived from hermeneutic interpretation within the context of connectivism as an epistemological paradigm. From the ontological dimension, connectivism is embedded in a relational and dynamic reality, as previously indicated; it exists in such a way that the subject ceases to be an ontologically closed entity—as is the case with theories about human thought in its generative phase—to integrate as, and at the same time become, a reticular system of nodes that foster circularity, recursivity, and the retroactivity of

[19] For a perspective on new realism, see the work of Ferraris (2020), which details the intense philosophical debates surrounding this fundamental concept. We do not discuss here the impact of new realism on the controversial situation of digital society and the connectivist paradigm. However, we highlight the idea that digital society presents itself in a controversial manner vis-à-vis the idea of reality that emerges from the virtuality of the connectivist lifeworld. These arguments are presented elsewhere, in preparation.

knowledge, transforming the space of interaction into a network of informational, technological, and social flows, which the connected human subject then converts into knowledge, despite epistemic illusions (Gabriel, 2024).

This allows us to consider that what is transcendent in cognitive theory—which is also the crucial point that positions it as novel—is represented by non-human nodes as well, which integrate into as connections that contribute to the body of knowledge (Siemens, 2004), an issue that further adds the strongest element to the discussion surrounding technological disruption in the digital age and connectivism as a social paradigm.

Learning and acquiring knowledge implies, within this network framework, actively participating in a constantly evolving knowledge ecosystem (Siemens, 2004; Villalobos, 2018)[20] . This does not mean that the network context did not exist previously, especially in terms of the articulation of research nodes. This must be made clear, as the concept of "knowledge networks" as such has long been a practice in scientific research[21] .

This leads us to consider that the networked knowledge system, as noted earlier, is dynamic and fluid, but that it is also subject to constant, immediate, and equally fluid transformations, in which not only knowledge is transformed, but the very subject of knowledge is transformed, since this change operates at the subjective level of knowledge (whether human or non-human). However, this has already been described in other contexts regarding the paradigms of knowledge with which connectivism is intertwined[22] .

The systemic ontology described previously, within which connectivism is situated, finds solid support in the theory of distributed cognition and the extended mind thesis, according to which cognitive processes are not limited to the human brain but extend to artifacts, devices, and digital environments (Siemens, 2004; Clark and Chambers, 2011). Thus, it is understood that knowledge—and therefore its acquisition—can no longer be comprehended without considering technological mediation as a constitutive part of the "extended" cognitive act ([23]). However, critical analysis reveals that this connectivist ontology can render invisible the historical, political, and economic conditions that structure non-digital human networks.

It is clear that the above implies the need for an ethical and critical reading of connectivism, especially in Latin American contexts marked by inequalities in network access and a lack of effective participation in knowledge acquisition processes in the sense of epistemic justice, which poses additional challenges for this onto-epistemic paradigm (Oliveros and Navas, 2025; Mata and Zepeda, 2022; Fricker, 2018).

To conclude this section, it can be stated that, in ontological terms, connectivism decisively challenges classical perspectives regarding the knowing subject, since the latter is unequivocally displaced from being an autonomous, stable, and self-sufficient entity in the human sense toward a relational human-machine coexistence, which is moreover subject to contingencies and articulated in a distributed manner; in this sense,

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[20] It is important to note that not only is the context of knowledge transformed, but all elements of interaction as well, as is the case with reality within the framework of knowledge in light of new paradigms of knowledge, especially those derived from quantum physics and molecular biology (Maturana and Varela, 2003; Hawking, 2020; Ferraris, 2020; Capra, 2008; Martínez Miguélez, 2016; Villalobos, 2018, among others).

[21] See, in this regard, Imre Lakatos's idea of *research programs* in: Lakatos (1989); Remache et al. (2024).

[22] Among others, these include the complexity paradigm (Morin, 2005), the paradigm of the fluidity of knowledge (Bauman, 2005), and the emergent paradigm (Martínez-Miguélez, 2005). See a discussion of the classical paradigms discussed and analyzed from the perspective of the complexity paradigm in: Martínez et al. (2026).

[23] In this regard, the section on the technological dimension provides further details regarding the ontological dimension in relation to distributed cognition and the extended mind, which are also part of this ontological dimension, as they represent an extension of being through technological devices that constitute the connectivity of knowledge and learning grounded in a rather complex form of cognition.

its identity as such is configured in, and through, computational interaction networks—that is, socio-technical structures based on digital technologies[24] .

Based on these arguments, both the "being" of the learning subject and that of the knowledge it appropriates can no longer be conceived as a substance whose meaning is apprehended in the Aristotelian sense—that is, as a fixed and immutable element[25] ; it is a closed internal unit, to be ultimately understood as a properly "situated," open, and co-emergent becoming, domains in which humans, digital artifacts (non-human entities), data, and algorithms participate in the production of meaning in situations of knowledge.

The connectivist ontology derived from Siemens' (2004) theoretical proposal certainly reveals a fundamental shift in the understanding of how knowledge exists, but also of who knows: learning is definitively connected under these parameters, so the subject will always be a "networked subject."

From all of the above, it follows that knowledge is produced, manifested, and generated in distributed, transient, contingent systems integrated into computational networks; while the knowing subject takes on a new definition as such a subject of knowledge by integrating into these systems more through its capacity to inhabit, traverse, and reconfigure the relational nodes that constitute it, than through its own subjective faculty of knowledge integration via its own neural system[26] .

Finally, regarding this connectivist ontology, we can draw the following conclusion: education in digital environments can no longer be based on an ontology of knowledge grounded in the mere individuality of the being; this requires the adoption of a reticular ontology of knowledge that recognizes interdependence, mutability, and complexity as the conditions that constitute learning in the digital society. Heideggerian ontology has addressed this relationship between being and its environment through the concepts of *Mit-sein* and *Sein-in-der-Welt*, issues already discussed in the philosophy of education elsewhere (Villalobos et al., 2024).

Let us now examine the technological dimension of connectivism.

Technological dimension: technology as an epistemic extension

To frame this discussion on technology as an epistemic extension, let us advance the following postulate: the technological dimension of connectivism reconfigures the entire landscape of knowledge in the era of digital society. Consequently, both the epistemological and ontological dimensions are established or grounded in the era of connectivity precisely through the technological dimension; it is the origin of the entire system reconfigured as the connectivist paradigm proposed by Siemens. In that sense, one of the most disruptive contributions of connectivism lies in the understanding of technology not as an instrumental tool, but as an ontological and epistemic extension of the human mind.

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[24] These are described by Zuboff (2020), Han (2020), Costa (2021), among others. Costa encompasses them in the category he proposes: *the technocene*. With this neologism, he refers to the human technological footprint on the planet; clearly, for both Costa and the other authors cited in this note, the phenomenon is thus presented in an alarming sense. This is also viewed in the same light by Crawford (2023). See also: Ochoa (2026). For a perspective on the inequality generated by technology from the standpoint of socio-technical networks: Mendoza (2026). For a perspective on the dangers of disinformation produced by artificial intelligence in socio-technical contexts, see: Limia (2025).

[25] Truth as correspondence, in the broadest and most extensive sense of the term (Jaeger, 2013; Sellars, 2024).

[26] This quality described by neuroscience has implications for this topic, based on some core questions we have posed in other contexts: What ontological and epistemological implications do computational devices have when connected to the human brain? What is the nature of knowledge in situations where the brain of the subject of knowledge is forced to make neural connections for non-therapeutic purposes? To explore this aspect of the problem, see: Villalobos (2024) and (2025).

It is at this point that the underlying problem lies. Digital platforms, algorithms, databases, and artificial intelligence all integrate into the human cognitive system, forming a new unit within the reticular cognitive plurality, transforming the way knowledge is produced and, even more so in the era of intelligent organizations[27] , the way knowledge is managed (Villalobos et al., 2023a and 2023b)[28] .

This approach reinforces the idea that teachers' digital competencies cannot be reduced solely to technical mastery of tools, since they incorporate, according to these arguments, epistemic, ethical, and pedagogical dimensions. Knowing how to search for, select, evaluate, and connect information becomes a core competency of the contemporary university teacher. Hence, the technological dimension is a fundamental pillar in the era of connectivism and the generation and management of knowledge.

For these reasons, we assert that the technological dimension of connectivism is perhaps the most controversial and, in some ways, one of the most disruptive; it represents a dimension that completely distinguishes the connectivist paradigm from the most common knowledge paradigms, as Siemens (2004) points out in the first paragraph of his work: cognitivism, behaviorism, and constructivism. Siemens not only recognizes the instrumental role of digital technologies but also conceives of them as part of the informational environment, although there is a tendency to view them as cognitive extensions—that is, as epistemic prostheses or "extensions" that transform the very nature of thought[29] .

This latter idea is linked to the epistemic notion of "distributed cognition" (Hutchins, 1995)[30] and to the "extended mind" thesis (Clark and Chalmers, 2011), according to which thinking also involves interacting with artifacts, devices, and environments. However, this idea requires a critical pedagogical view of technology: it is not enough to simply connect to the network; one must know how to do so, why to do so, and with whom to interact in order to acquire knowledge and, indeed, to learn, while adopting a decidedly critical stance.

The digital literacy posited by Siemens (2004) is precisely the idea of "knowing how to search" in a chaotic and complex environment, such as the current internet-based network; that is to say, this knowledge is not reduced to mere technical competence: it must include ethical, political, and epistemological awareness of the digital environment, in addition to the human subject possessing special qualities—which are formed during the process—to navigate a sea of uncertainties and chaotic situations, as Morin (1999)[31] argues, in reference to knowledge environments in complex and systemic contexts.

This idea is worth discussing in this paper in light of the position taken by Clark and Chalmers (1998) [2011][32] , who, in proposing the concept of the "extended mind," offer important arguments for understanding the role of technology in the learning process, incorporating it as another element of the system. The question

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27 For a perspective on universities as intelligent organizations and their relationship to knowledge production and management, see: Villalobos-Antúnez (2013), Moscoso and Pulla (2024), Veintimilla (2023), Guzmán and Pico (2024).

28 For a perspective on this phenomenon during the pandemic, see: Sapién et al. (2020).

29 Especially in the era of neurotechnologies (Villalobos-Antúnez, 2024), in which the concepts of "thought" and "interconnection" are posited, alongside technologies that directly intervene in the brain, with real possibilities of manipulating thought itself, and thereby decision-making, affecting fundamental rights (Yuste et al., 2017; García, 2025).

30 Other authors have developed the concept of "distributed cognition": Chamat (2025). Fuentes refers to it as "cognitive collaboration" to denote the idea of "distributed cognition" but in the context of generative AI: (Fuentes, 2025).

31 See also: Zhou (2025); Martínez et al. (2026).

32 From this point forward, we will cite the 2011 publication by these authors. See also: Hernández (2025), Castaño and Izquierdo (2026), and especially Gahrn-Andersen (2026), who explains how the algorithmic structure of technology contradicts Clark and Chalmers' "extended mind" hypothesis. This aspect is not discussed in this paper.

that arises from these ideas when comparing them in this research is how to relate Siemens' (2004) connectivist theory of learning to Clark and Chalmers' (2011) theory of the extended mind, in a way that sheds light on how to know and how to acquire new learning in digital and connected environments from their epistemic perspectives.

Connectivism, the Extended Mind, and Cognitive Distribution

In accordance with the preceding ideas, within this line of thought regarding Siemens' (2004) theory of learning and Clark and Chalmers' (2011) theory of the extended mind, it can be noted that both theories share a novel and transformative premise: knowledge and cognition are not confined to the human brain; rather, their foundation lies both in the mind in the internal sense and in the fact that they are distributed across internal-external hybrid systems that include artifacts, technologies, environments, and social networks (Latour, 2008).

In this sense, Siemens (2004), whose approach from this perspective can be considered a form of *digital pedagogy*, argues, as previously stated, that learning and knowledge occur at the connection between nodes formed by humans and non-humans, as noted earlier, and that the ability to *know where* to find information is more important than possessing it—a point that is as controversial as it is disruptive.

In relation to the above, this paper posits the idea that *knowing where* complements both *knowing what* and *knowing how* in an epistemic-pedagogical sense (Vargas Guillén, 2006; Rojas, 2025). Clark and Chalmers (2011)[33] , drawing on their conception grounded in the philosophy of mind, argue that cognitive processes can extend into the environment when it performs functions equivalent to the brain's internal functions.

Thus, based on the above, the extension of the mind becomes the key dimensional issue for understanding this relationship between connectivism and the extended mind: as understood from the cited authors, the knowing subject articulates its brain function by considering, or assimilating, that there is no break in continuity between the mind (in its sense of internal mind) and the subject's environment, which is articulated in the world of human/non-human relations, shaped by the technological context studied here (in its sense of external mind), though also with the socio-anthropological context that gives it meaning as a being-in-the-world (*Sein-in-der-Welt*).

The above idea is clearly illustrated through the well-known example of Otto and his notebook, presented by Clark and Chalmers (2011). This emblematic case demonstrates that devices used systematically, reliably, and functionally for information retrieval can be considered integral components of the individual's cognitive system. From this perspective, knowledge is not restricted to the internal limits of the human mind, but can be distributed across artifacts external to the subject, databases, networks, and digital devices, which fully aligns with the connectivist principle that knowledge can reside outside the subject[34] .

Consequently, technology is no longer conceived solely as a means of learning but is instead understood as a constitutive part of the cognitive architecture of the networked subject. Along these same lines, Salomon (2001) points out that distributed cognition neither nullifies nor replaces individual cognition, but rather emerges precisely from the dynamic interaction between the subject, technological artifacts, contexts, and other social actors, among whom subjective differences may be observed, yet it is the system itself that unifies them

[33] A critical position is reflected in the work of Salinas (2025), who links his study to the work of Sanguineti (2008), among other works by the same author. Sanguineti's thesis is framed within the idea of posthumanism as a critical manifestation of externalism and the extended mind. See also: Rowlands et al. (2020).

[34] Although it can be stated with certainty that this aspect of knowledge located in technological extensions can only be considered as such once it is retrieved by the elements of the system (human or non-human).

as a single system. This is the same conception as Hutchnis's: "The navigation team can be seen as a cognitive and computational system in which the properties of the system differ from those of any individual"[35] (1995, xiii).

From the above, it is understood that the human mind does not dissolve into the network; rather, it is amplified as a result of its interaction with that complex environment that constitutes the individual's underlying world, reorganizing and transforming itself alongside that environment. Salomon (2001) proposes not a linear interaction with the environment, but rather that the relationship takes the form of an interactive spiral in which all elements intersect: the technological, the social, and the symbolic. This interactive environment then provides feedback, reorganizes, and enhances the aforementioned cognitions. Thus, distributed learning is not a passive instance of knowledge; it is actively co-constructed between the subject and their cultural extensions (Salomon, 2001; Huchtnis, 1995; Latour, 2008).

Ultimately, the ideas of the extended mind and cognitive distribution enrich the technological dimension of Siemens' (2004) connectivism by emphasizing that technology does not replace the mind, but rather challenges it to reorganize itself in light of the new contexts that emerge and where it is deployed: from this perspective, it is understood that the connected subject is not merely a node, but an agent who negotiates, interprets, and transforms their connections within the digital network with a view to generating knowledge and networked learning.

The technological dimension constitutes the context in which *Dasein*, "being-there," unfolds—that is, the ontically constituted subject of networked knowledge; the network is the medium that enables and defines it; without it, the cognitivist paradigm would have no possibility of unfolding: it has emerged as the medium in which distributed cognition and the reality of the extended mind originate.

Let us now examine the pedagogical dimension, in order to complete our interpretation of George Siemens' (2004) connectivist paradigm.

The Pedagogical Dimension of Connectivism: Implications for Higher Education

On the pedagogical level, connectivism profoundly redefines traditional roles. For this reason, we argue, along with other authors, that the teacher ceases to be a transmitter of content and instead becomes a mediator, curator, and designer of networked learning environments (Mulumeoderhwa, 2024; Bermeo et al., 2025, among others). The student, for their part, assumes an active, autonomous, and reflective role, navigating complex informational environments critically.

However, this pedagogical reconfiguration introduces substantial challenges for educational quality, particularly regarding the assessment of learning, the validation of knowledge, and equity in access to meaningful learning networks. Quality can no longer be measured solely by quantitative indicators, but rather by the institutional capacity to generate critical, inclusive, and sustainable learning ecosystems.

In the context of networked learning, the teacher ceases to be a mere transmitter of content and becomes a facilitator, but also a designer of connection experiences and, consequently, of access to networked knowledge. For their part, students are also reconfigured from their traditional role as mere or passive recipients, despite the presence of active methodologies since the late 20th century, which transformed this element of the educational equation into an active agent (Tobón, 2013; regarding methodologies in digital environments: Solórzano et al., 2025; Cárdenas and Padilla, 2026).

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[35] "The navigation equipment can be considered a cognitive and computational system in which the properties of the system differ from those of any individual" (Translation by the authors).

In contrast, in connectivist contexts, the student is also an agent navigating an ocean of information to construct knowledge, but it is clear that they must select and simultaneously reconfigure their own learning environment through a new way of addressing their own questions regarding knowledge, thereby transforming themselves into an autonomous entity within the pedagogical process.

This connectivist conception is simultaneously aligned with emerging pedagogies that previously reconfigured the roles of teacher and student based on new educational trends regarding the role of subjectivity in learning, but it also articulates with other types of methodologies, such as project-based learning, problem-based learning, or role-play-centered learning, among others, all of which have been integrated into the competency-based approach—that is, configured with active learning methodologies (Tobón, 2005; Díaz, 2024; Solórzano et al., 2025; Cárdenas and Padilla, 2026).

Notwithstanding the above, this pedagogical dimension of the connectivist paradigm poses challenges in terms of equity, support, and assessment in digital contexts. In the realm of computer networks and electronic devices with internet access, new epistemological challenges arise, giving rise to questions of great concern not only in a pedagogical sense but also in philosophical, ethical, and political terms: Do all students have the same conditions to build meaningful networks? How is the quality of connections assessed? What are the criteria that allow us to distinguish between information and knowledge? Or more precisely, how does this connectivist pedagogical conception impact the quality of education?

These questions have resonated strongly in the field of education, since the information circulating on digital networks is often classified as true not only without any epistemological basis, but also, in most cases, without any theoretical or epistemological validation (Serrano, 2016; Gallego, 2025; Pylypenko et al., 2026).

The above, as analyzed here, raises serious doubts about online knowledge. In fact, information "embedded" in the network is considered an epistemic risk, since the way information circulates leads the information consumer to assume that it is true without further question, which creates barriers to learning in advance when what is reported or received as such is not critically evaluated—unlike, for example, when such information is validated using reliable sources or the logic of knowledge itself. The prevailing tendency is not to verify the vast amount of information received, with major consequences for the conception of the truth of knowledge, and implications for educational quality[36] .

Finally, in this pedagogical dimension, connectivism implies a profound reconfiguration of teaching and learning practices by shifting the emphasis from the transmission of content toward the design of environments that foster the active construction of networks, autonomous exploration, and informed decision-making in contexts of high informational complexity. Connectivist pedagogy, as derived from Siemens' (2004) postulates, conceives of the teacher less as an exclusive mediator of knowledge and more as an architect of learning experiences, responsible for enabling connections, promoting the critical curation of knowledge, and stimulating metacognition regarding one's own learning processes[37] .

Learning within this framework of connectivity does not consist of mastering a closed body of knowledge, but rather of developing competencies to learn continuously, recognize patterns, update knowledge, and actively participate in distributed knowledge communities. In this way, the pedagogical dimension of connectivism challenges linear and standardized teaching models, proposing instead a flexible, adaptive, and

[36] This aspect of knowledge places the interpreter on the path of what is proposed in Gabriel (2024): the idea of false knowledge as an aspect of cognitive reality.

[37] Logically, this also has significant implications for leadership development in educational contexts. A perspective on this can be found in: Catalán et al. (2020)

context-based pedagogy consistent with the mutable nature of digital knowledge and the educational demands of higher education in the digital society.

Organizational Dimension

The analysis presented so far leads to the conclusion that connectivism poses a particular challenge to universities, demanding not only profound organizational transformation but also a commitment to the changes generated in and by the digital society[38] . Universities serve as nodes in the cognitive system, responsible for managing information flows, promoting collaboration, and ensuring educational quality in digital environments.

In this sense, an essential element of connectivist theory—which also symbolizes the paradigm shift in learning within the digital context—is the organizational sphere, where networked learning in the educational realm of this modern era primarily takes place, and from which educational institutions are called upon as responsible for teaching processes with a new horizon: the transformation of society in every sense[39] .

This is why Siemens (2004) proposes a vision of organizations in his connectivist theory as self-organizing systems, capable of learning, adapting, and evolving[40] . However, while universities are considered fundamental to the education system, focused on the training of the individual, their role is that of a mediator within the system when viewed from the traditional perspective of learning paradigms, such as those mentioned by the author.

Connectivist theory redefines the structures that make up the educational system to position universities not as closed systems; it places them in synergy with educational development oriented toward learning by considering them an important node in the knowledge system; from classical theoretical contexts, universities were, in an epistemological sense, situated outside the systemic framework, as this framework centered on the student-teacher relationship (Villalobos, 2013).

However, from the perspective outlined above, the educational institution is conceived as an organization in its own right, given its role in structuring knowledge and the curriculum, thereby linking it to the theory of the intelligent organization and knowledge management as strategic pillars of the system, thus establishing a synergistic structure for the learning process (Senge, 2010; Villalobos, 2013).

Thus, in this paper, we clearly see that university educational quality cannot, consequently, be reduced to quantitative indicators, although these are of vital importance for decision-making; rather, the quality of educational processes is also measured by the organizational (institutional) capacity to generate information flows, promote collaboration, and create and sustain learning ecosystems. Since, from a connectivist perspective and considering knowledge contexts, institutions become yet another node in the interconnected digital system—clearly situated alongside students and faculty— but also by examining their internal context from the perspective of university organizational management itself (Villalobos et al., 2010).

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[38] We have argued in other contexts that digital society is largely an environment of uncertainty. See Villalobos et al. (2023a) for how the environments of uncertainty generated by the digital age trigger processes of epistemic uncertainty in organizational contexts. For a perspective on self-organizing systems and their application in university settings through AI, see: Meneses (2025). To explore a novel and interesting aspect of this idea regarding self-organizing schools in digital contexts, see the review by González (2026), in which he describes the innovative self-organizing system proposed by the educator Mitra (2020). See also Caicedo (2025) for a comprehensive understanding of self-organizing systems in relation to the entropy of social systems.

[39] Han (2020) has characterized this context as *a swarm society*, to highlight the critical trend of this connectivity in digital society.

[40] However, this is not the novel aspect of the theory, since this context has already been characterized in previous works: Morin (1995 and 1999), Capra (1992), Martínez (1998). An interpretation of the phenomenon can be found in: Villalobos et al. (2023b).

It is evident that this is a systemic and complex vision that is present in connectivist theory; however, it demands a transformation of the classical hierarchical structures that make up educational organizations, especially regarding the axis of authority within which this theory is embedded in all educational systems of modern society, and it also requires new models of governance and new cultural forms of academic structuring to integrate with the dynamics of the digital world and connectivist learning.

In the specific context of universities, the organizational dimension of Siemens' (2004) connectivism is reflected in the process of harmonizing educational quality, which, incidentally, has legal standing in Ecuador and other countries in the Spanish-speaking American region (Ecuador, 2020; Chile, 2011; Colombia, 2010; Argentina, 2006; Mexico, 2021).

Axiological Dimension

This is one of the most significant dimensions for the digital context, an issue that is critically examined due to the great importance of values in the technological context. From the axiological dimension, connectivism proposes an ethics of learning based on openness, diversity, and epistemic justice. Networked learning requires critical discernment, ethical responsibility, and a commitment to the democratization of knowledge, avoiding the uncritical commodification of digital education. What connectivist theory proposes is the idea that learning is participating in communities of practice, sharing knowledge, and constructing knowledge through networks.

The perspective outlined in the previous paragraph clearly aligns with other principles arising from the concept of the information society and the digital society, such as the principles of free software, open science, and education as a common good (Barreto, 2019; Rosell et al., 2023; Barrientos et al., 2025), despite major and successful attempts at privatization and the reduction of such spaces, and despite the growing commodification of education.

However, due to the above, this process of shaping a networked society also requires critical oversight by all stakeholders: the state, civil society, NGOs, the church, universities, philanthropic individuals, among others; connectivity alone does not guarantee epistemic justice (Arrecillas and Miker, 2025; Díaz, 2025; Montesdeoca et al., 2025; Martin et al., 2022). As Miranda Fricker (2017) and Boaventura de Sousa Santos (2009) warn, it is necessary to democratize not only access to knowledge, but also the criteria for validation, the languages, and the forms of knowing. The knowledge networks built through digital technologies pose a major challenge to the principles of an ethics of knowledge as well as to networked learning.

In light of the above, this research began with the premise that connectivism demands a high degree of discernment from the internet user; in other words, the user of digital networks—whether a teacher, a student, or the institution in an organizational sense—is required to exercise discretion regarding networked knowledge. This necessitates a critical and reflective approach to learning, thereby shaping an ethics of knowledge in connectivist contexts.

The aforementioned triad (teacher-student-university) is of interest for the purposes of this line of research, since logically there is a multidimensional diversity of actors in the network that impacts this configuration, from which emerges the axiological dimension of connectivism as an integral element of the theoretical structure. This discernment implies what Fricker proposes in her cited work, namely, the justice of social actors in the process of hermeneutic determination of the information that arises in the process of establishing truth in the epistemic sense (Villalobos et al., 2022a).

It is argued from this perspective, and in conjunction with the positions of Siemens and Fricker, that the aforementioned dimension of connectivist learning theory requires recognizing, including, and dignifying all individuals as legitimate bearers of knowledge, therefore, the act of knowledge also requires actively

corroborating and correcting the biases that are evident and emerge in its production process, in order to ensure full participation in the network, since processes in digital networks in turn demand participation in terms of listening, translation, and understanding of meanings, but ultimately, they require integration into the process of cognitive transformation. The latter, as presented, constitutes the core of the process established by Siemens' (2004) connectivist theory.

Conclusions

The analysis conducted leads to the conclusion that George Siemens's connectivism constitutes a relevant epistemological framework for understanding the transformations of knowledge and learning in contemporary higher education. Its fundamental contribution lies in highlighting the distributed, relational, and technological nature of knowledge in the digital society.

However, connectivism cannot be assumed to be a self-sufficient paradigm. Its transformative potential requires integration with critical, socio-formative, and ethical approaches that preserve the reflexivity, epistemological validation, and social responsibility of the educational act. In this sense, teachers' digital competencies emerge as a strategic pillar for ensuring educational quality in connectivist contexts. These competencies must be understood as comprehensive capabilities that integrate technological knowledge, critical thinking, the ethics of knowledge, and networked pedagogical mediation.

Finally, the hermeneutic interpretation and analysis conducted allow us to conclude that the main challenge of connectivism for higher education is not technological, but epistemological and pedagogical: to train teachers and students capable of critically engaging with the network, transforming connectivity into meaningful and, ultimately, socially responsible knowledge, which is in line with the ethical processes of smart educational organizations (Villalobos et al., 2023a).

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