THE ALGORITHMIC SELF BETWEEN SEMANTIC IMPOVERISHMENT AND NEW CITIZENSHIPS SYSTEMIC TRIANGULATION AS A DEVICE OF AGENCY AND SOCIAL PRODUCTIVITY

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ABSTRACT
The irruption of AI into education represents an ontological transformation reconfiguring knowledge validation and subjectivation. Rather than just integrating intelligent tools, it requires reflecting on new structural conditions where knowledge is managed by automated systems. In this framework emerges the Algorithmic Self: a personal identity reshaped by digital flows, exposed to cognitive homologation and semantic impoverishment. Drawing on Floridi's Infosphere, the subject is restructured through the externalisation of cognitive functions. To counter these issues, this paper develops the Systemic Triangulation model (Human–Environment–Technology) (Mancarella, 2026). It recentres the coevolution between human, context, and technology, viewing learning as socially shared knowledge production. The model translates into operational implications for inclusive didactic design and a critical algorithmic citizenship, grounded in Sen's capabilities (1999).

KEYWORDS
Algorithmic self; algorithmic triangulation; artificial intelligence; social production; semantic impoverishment.

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1. Introduction: the ontological transformation of education in the algorithmic era

The irruption of Artificial Intelligence (AI) into educational contexts does not merely constitute a phenomenon of technological innovation or a digital transition of instructional tools. Rather, it represents a transformation that disrupts the ontological foundations of the educational act itself. As predictive and automated systems become the primary and pervasive mediators of knowledge production, categorization, and organization, the educational act undergoes a structural mutation. This mutation fundamentally alters the relations between subjects, knowledge, and the surrounding phenomenological horizon (Paparella & Mancarella, 2025). Recent pedagogical literature has begun to interrogate this transformation with increasing urgency. Authors such as Biesta (2015) and Fullan (2007) had already highlighted the risks of an instrumental conception of education—one oriented toward the production of measurable competencies rather than the cultivation of subjects capable of critically inhabiting the world. The advent of generative AI systems brings this tension to a definitive breaking point, as the machine ceases to function as a passive support for learning processes and mutates into an active agent capable of shaping, anticipating, and occasionally replacing human cognitive functions. In this altered landscape, the fundamental pedagogical question shifts away from purely methodological or applicative urgencies. Instead, it compels a radical reflection on the dynamics of identity reconfiguration that the subject undergoes at the very moment interaction with the algorithm becomes constitutive of the epistemic experience. Within this framework, the core pedagogical question is not how do we use AI?, but rather who are we becoming while we use it?.

2. The algorithmic self and semantic depletion

The notion of the algorithmic self specifically designates that dimension of personal identity which is constituted and reconfigured within the continuous relational flow with digital technologies, thereby blurring the traditional boundaries between the biological and virtual spheres (Paparella & Mancarella, 2025).

This process of subjectification is not situated within an area separate from the historical and phenomenological identity of the subject; rather, it represents one of the structural modalities through which contemporary identity is formed, stabilized, and transformed under the influence of technical apparatuses. Algorithmic technologies operate through sophisticated mechanisms of recommendation, profiling, and automated personalization that constantly shape the cognitive experience of individuals (Zuboff, 2019). Social media feeds, search engine recommendation systems, and intelligent tutors within e-learning systems: each of these devices does not merely respond to pre-existing preferences, but actively concurs to produce, reinforce, and transform them into relatively stable structures of attention, interest, and meaning (Zuboff, 2019). The identity that emerges from this is, to an increasing extent, the product of feedback loops between the subject and the algorithmic system. This process of algorithmically mediated identity constitution is not intrinsically pathological; indeed, every identity formation occurs through symbolic and cultural mediations. The problem emerges when algorithmic mediations are characterized by a systematic reduction of complexity and of the semantics of experience, when the polyvalent richness of meaning is flattened onto statistical relevance, and when the capacity to sustain open interpretative tensions is replaced by the immediate gratification of computational validation (Turkle, 2015). The concept of semantic depletion precisely designates this process of impoverishment, namely the progressive reduction of the density of meaning within cognitive and relational experience under the effect of algorithmic logics. This process manifests itself on multiple levels. On the cognitive level, semantic depletion translates into an increasing difficulty in sustaining interpretative complexity. Subjects formed in high-algorithmic-density environments exhibit a marked tendency toward simplification, the search for unequivocal answers, and the devaluation of semantic ambiguity, which should instead be understood as a fundamental hermeneutic resource rather than an obstacle to be removed (Kahneman, 2012). Reflective and slow thinking progressively gives way to automatic and fast cognitive processes, oriented toward immediate confirmation, precisely because digital environments are designed to accommodate the minimization of critical effort (Kahneman, 2012). On the relational level, semantic depletion manifests itself in the impoverishment of empathetic and dialogical capacities. Turkle (2015) has documented how communication mediated by digital devices tends to reduce tolerance for the slowness, ambiguity, and unpredictability that characterize authentic human relations. When algorithmic interaction becomes the dominant paradigm of communication, interpersonal relationships tend to be evaluated according to criteria of efficiency and immediate gratification, which compromise their ethical depth.

On the epistemic level, semantic depletion produces a transformation in the validation criteria of knowledge; truth risks becoming that which the algorithmic system confirms with greater frequency and precision, rather than that which withstands critical scrutiny and intersubjective verification (Floridi, 2009). This transformation has direct consequences for education: if knowledge is merely what the algorithm certifies, the critical and evaluative function of both the teacher and the learning subject is progressively weakened. The theoretical framework developed by Floridi (2009) through the concept of the Infosphere offers a powerful interpretive lens for understanding the scope of these transformations. The Infosphere designates the overall informational environment inhabited and navigated by contemporary subjects; it represents an environment where the distinction between online and offline tends to dissolve, where informational artifacts acquire an ontological density of their own, and where the boundaries between human and artificial agents become increasingly blurred. In this context, the subject is not merely influenced by AI, but is fundamentally restructured. Cognitive functions traditionally ascribed to the subject, memory, attention, evaluation, decision-making, are progressively externalized and delegated to artificial systems. This process of cognitive externalization does not possess an intrinsically negative connotation, as writing and printing have historically enhanced human capacities; yet, the current problem emerges when this delegation occurs in the absence of a widespread critical awareness.The tangible risk resides in the circumstance wherein the subject externalizes cognitive functions without maintaining the strategic capacity to reclaim them, thereby rendering the dependence on artifacts structurally invisible and pervasive (Floridi, 2009; Rosa, 2020). The resulting functional reduction of the individual does not solely concern individual intellectual faculties; rather, it directly impacts the capacity to actively participate in democratic life, to exercise autonomous moral judgment, and to structure authentic relationships of care and reciprocity (Rosa, 2020).

3. Algorithmic Triangulation

The educational relationship has been traditionally conceptualized as a dyadic relation, such as teacher and student, master and disciple, expert and learner. This binary structure has historically underpinned the main Western pedagogical traditions, including those currents most attentive to the social and contextual dimensions of learning, which have often maintained the dyad as the fundamental analytical unit of reference (Vygotsky, 1978). The irruption of AI into educational contexts renders this dyadic structure epistemically insufficient. This does not imply calling into question the centrality of the intersubjective bond between teacher and student, but rather recognizing the impossibility of conceiving it in the abstract without introducing a third structural term constituted by the environment (Mancarella, 2026). The Human–Environment–Technology algorithmic triangulation (Mancarella, 2026) does not merely add a third element to the dyad; rather, it transforms the very structure of the educational relationship, introducing dynamics of co-evolution and the collective production of knowledge that the dyad was incapable of capturing. Knowledge thus ceases to be interpreted as an exclusive property of the subject or as the outcome of a linear transfer of information, manifesting itself instead as an ecological and emergent property of the integrated triadic system (Mancarella, 2026). The fundamental theoretical reference of the model is Gestalt psychology and, in particular, the field theory developed by Kurt Lewin (1936, 1961). Lewin, trained within the Berlin school of Gestalt, inherited its core principle according to which experience is not a sum of single isolated elements, but a structured totality in which the whole is more than the sum of its individual parts. Applying this epistemological vision to social psychology, Lewin theorizes that behavior is determined neither by the internal structure of the subject (in an isolated manner) nor by the purely objective characteristics of the environment, but rather by the dynamic and interdependent relationship between subject and environment at any given moment. This principle of global interaction is synthesized in his famous psychological formula:

$$C=f(P,A)$$

In this equation, behavior (C) is defined as a function (f) of the Person (P) and the Environment (A), elements that cannot be analyzed separately. Consequently, the psychological field, or life space, represents precisely the total configuration of facts, forces, and psychic tensions which – exactly as occurs with the laws of perception in Gestalt – determine the behavior of an

individual at a given instant. Applied to the context of education in the algorithmic era, field theory suggests that learning occurs neither within the subject nor as a mere effect of the technological environment, developing instead within the dynamic field that emerges from their recursive interaction.

The third vertex, represented by the physical, social, and symbolic environment, does not constitute a neutral or passive background, configuring itself as an active pole capable of orienting, constraining, amplifying, and transforming the interactions between the human and the digital artifact. While the subject modifies the environment through their situated practices, the environment shapes the subject's possibilities of action, and technology simultaneously transforms both poles within a continuous recursive loop. Thus, the Human–Environment–Technology triad is born: a dynamic system in which each pole influences the others and is, in turn, influenced by them.

In formal terms, the algorithmic triangulation model can be expressed as a dynamic system of three interdependent variables (Mancarella, 2026), where:

- *U* represents the human pole of cognitive and value-based capacities;
- A identifies the environmental pole of physical and symbolic forces;
- T defines the technological pole of algorithmic architectures.

The knowledge produced within the system (Ψ) is configured as an emergent function of their reciprocal interactions (Mancarella, 2026):

$$\Psi = f(U \times A \times T)$$

In this formula, the symbol x does not denote an algebraic multiplication, but rather a relationship of dynamic co-evolution. This formalization aligns coherently with the theoretical horizon that expresses the cognitive value of the hybrid system and the human–machine intentionality coefficient over time (Mancarella, 2026). The human intentionality coefficient represents an irreplaceable strategic lever that can in no way be delegated to automated systems (Mancarella, 2026). It identifies the subject's capacity to consciously orient their own cognitive process, to assume a specific epistemic responsibility regarding their own epistemic choices, and to keep the question of meaning open even in the face of apparently exhaustive and efficient algorithmic outputs (Mancarella, 2026).

In the final analysis, the presence of such a coefficient ensures that interaction with the machine does not degenerate into blind automatism, thereby preserving the hermeneutic depth of the epistemic act (Paparella & Mancarella, 2025). Within the algorithmic triangulation model, the environment performs a specific and irreplaceable function: that of a stable vertex capable of providing meaningful coordinates to the algorithmic self, preventing its dissolution into the fluidity of the infosphere. This stabilizing function of the environment does not derive from an inherent immutability – as the environment is itself a dynamic system in transformation – but rather from its symbolic density and its capacity for resistance against algorithmic liquidity. In its Lewinian sense, the environment encompasses physical dimensions (corporeal space, territory, sensory contact with material reality), social dimensions (relationships of care and reciprocity, community bonds, shared practices), and symbolic dimensions (cultural repertoires, interpretative traditions, value systems). These dimensions offer the subject anchoring resources that algorithmic systems, by their very nature, cannot provide, such as the resistance of the real, the irreducibility of the other, and the historical depth of meaning. The algorithmic triangulation model does not promote a naive pedagogical techno-optimism, nor does it claim that the integration of Artificial Intelligence is intrinsically beneficial for educational processes (Mancarella, 2026). More precisely, it contends that such integration can become beneficial when it is mediated by an environment rich in symbolic and relational resources—one capable of offering the subject the coordinates necessary to avoid becoming lost in the fluidity of the infosphere (Floridi, 2009; Mancarella, 2026).

4. Social productivity of the educational relationship and agency

A further, decisive advancement of the algorithmic triangulation theory lies in the structural reconfiguration of the inherent aims of the educational relationship, here articulated according to the paradigm of social productivity. This theoretical construct, which introduces and formalizes the status of systemic triangulation, designates the intrinsic capacity of educational action to generate externalized value, one that is not exhausted within the subjects linearly involved in the instructional exchange, but rather extends to the entire surrounding social community of reference. Unlike the traditionally understood educational relationship as a dyadic teacher–student exchange, which tends to produce a predominantly private value wherein the knowledge and skills acquired by the learner constitute individual capital, the paradigm of systemic triangulation dismantles this solipsistic posture. It suggests that a fully realized

educational relationship necessarily translates into the co-construction of shared knowledge. Educational action thus becomes the vehicle for the articulation of the common good, establishing social bonds founded on the principles of reciprocity and intersubjective trust. This perspective aligns programmatically with the pedagogical tradition of Deweyan pragmatism (2014), according to which education is configured as a continuous process of reconstruction and emancipation of experience, oriented toward the convergence between individual growth and collective development. Today, within the complex framework of cognitive automation, the faculty to produce and socially negotiate knowledge ceases to be a mere pedagogical objective and mutates into a crucial strategic resource. In such a scenario, the educational institution assumes the fundamental political and ethical mandate to protect and promote the public space of sharing, standing as a critical safeguard against the centrifugal and atomizing impulses of contemporary techno-capitalism. Within the framework of the systemic triangulation model, the notion of agency acquires a specific and operational meaning. It does not simply concern the capacity to act autonomously, nor does it refer solely to technical competence in the use of digital tools. Educational agency designates the capacity to keep the educational relationship open through a critical mediation, alongside the ability to interrogate one's own cognitive processes, to recognize the partiality of algorithmic outputs, and to maintain the tension between computational efficiency and semantic comprehension. This conception of agency links to the work of Priestley, Biesta, and Robinson (2015) on teacher agency, which conceptualizes teacher agentic capacity not as a stable individual trait, but as an emergent quality realized in the interaction between individual resources, institutional contexts, and situated practices. Extended to the learning subject – and, more generally, to all participants in the educational relationship – this conception suggests that agency cannot be developed in isolation, but requires environments that support and exercise it. Agency, in this sense, is not a property of the individual but rather a relational quality that emerges in the interaction between the subject, their environment, and the technologies that mediate their practices. The systemic triangulation model does not interpret Artificial Intelligence as an ontological threat against which to defend oneself, nor as an intrinsically neutral tool to be uncritically adopted within classrooms. Instead, it is conceived as an active pole of the triadic system, suited to perform crucial functions of cognitive support and personalization of educational pathways, provided it remains strictly subordinate to the subject's critical agency and embedded within a dense relational context (Mancarella, 2026).

From this specific perspective, the algorithmic infrastructure can be converted into a powerful ally for the emancipation and expansion of learners' substantive freedoms (Mancarella, 2023). Intelligent systems can amplify access to vast repertoires of situated knowledge and offer real-time adaptive feedback, enhancing cognitive self-regulation processes—on the condition that the overall instructional framework is explicitly designed to develop, rather than erode, the subject's capacity to exercise independent judgment (Sen, 1999).

5. Discussion

In recent decades, the public and institutional debate on education in the digital era has been dominated by the notion of digital competence, understood as the capacity to effectively use available technological tools. This notion, while valuable within the context of a rapidly transforming technological society, proves epistemically insufficient when facing the challenges posed by generative AI and pervasive algorithmic systems. Digital competence, in its prevailing sense, measures the technical mastery of tools; it does not measure the capacity to critically inhabit the infosphere. The systemic triangulation model proposes the adoption of a decidedly more demanding normative criterion, identified as the semantic depth of the educational experience (Mancarella, 2026; Paparella & Mancarella, 2025). A learner who is capable of interacting effectively with a generative AI system, but is unable to critically evaluate its outputs, recognize its implicit assumptions, or integrate its responses into a broader interpretive framework, has not developed true competence; rather, they have developed an epistemically blind technological dependence (Paparella & Mancarella, 2025). Semantic depth postulates the subject's capacity to preserve and enhance the density of meaning of their own intellectual activity in the presence of technological mediations, thereby sustaining hermeneutic ambiguity and integrating digital stimuli into a critically grounded synthesis (Paparella & Mancarella, 2025). The notion of algorithmic citizenship that emerges from this reflection is neither a legal category nor a technical competence: it is an educational practice, a form of life, constructed through the daily exercise of critical mediation in the interaction with algorithmic systems. It is founded upon three complementary dimensions. The first dimension is epistemic awareness: the capacity to understand how algorithmic systems produce knowledge, what implicit assumptions guide their recommendations, and what categories structure their outputs. This awareness does not require an in-depth technical expertise in computer science or machine learning; rather, it demands a basic epistemological literacy that enables the critical interrogation of any source of knowledge, whether algorithmic or human.

The second dimension is relational agency: the capacity to maintain and develop meaningful relationships with other human subjects, founded on reciprocity, care, and mutual recognition, even within highly technology-mediated environments (Priestley et al., 2015). This dimension directly recalls the stabilizing function of the environment within the systemic triangulation model: authentic human relations offer the subject the coordinates of meaning that algorithmic systems cannot provide. The link between algorithmic citizenship and Sen's capability approach (1999, 2021) is not ornamental; it is structurally foundational. Sen's approach redefines human development not as economic growth or an increase in measurable performance, but as the expansion of individuals' substantive freedoms, their capability to lead the lives they have reason to value. Applied to the educational context, this approach suggests that the ultimate criterion of education is neither cognitive performance nor labor market adaptation, but rather the expansion of each subject's real freedom to actively participate in collective life. From this perspective, algorithmic citizenship is not an additional objective of contemporary education: it is the form assumed, in the algorithmic era, by the purpose classically attributed to liberal education the cultivation of free, critical subjects capable of contributing to the common good. AI becomes an instrument of emancipation when it contributes to expanding this freedom; it becomes an instrument of homogenization when it compresses it, replacing critical judgment with algorithmic conformity. The transition from the theoretical to the operational dimension is, for any pedagogical proposal, the ultimate litmus test of its fecundity. The systemic triangulation model offers a structured framework for the design of instructional pathways that coherently integrate the human, environmental, and technological dimensions of learning. In operational terms, an instructional design founded on systemic triangulation must satisfy three fundamental conditions. The first is environmental integration: instructional pathways must include experiences that anchor learning to concrete physical, social, and symbolic contexts, thereby avoiding the total virtualization of the educational experience. This does not imply renouncing the potential of digital systems, but rather inscribing them within environments rich in semantic density. The second is critical mediation: instructional pathways must include explicit moments of reflection on the use of algorithmic tools—not only on their technical efficacy, but on their implicit epistemology, their assumptions, and their limitations. The third is the social production of knowledge: instructional pathways must foster the collective construction of knowledge through practices of collaboration, negotiation, and sharing that cannot be replicated by automated systems.

Inclusive didactics finds a particularly significant theoretical ally in the systemic triangulation model. Inclusion, in the deepest sense of the notion, not merely as the physical integration of students with special educational needs, but as the construction of environments where all subjects can actively participate in the production of collective knowledge, precisely demands that attention to the co-evolution between human, environment, and technology that the model proposes. Assistive technologies and adaptive AI systems can significantly contribute to making the educational experience more accessible and equitable. However, the risk of an inclusive didactics predominantly oriented toward algorithmic personalization is that of producing isolated and self-referential learning trajectories, wherein each subject follows their own individualized pathway without participating in the construction of common knowledge. Systemic triangulation suggests that authentic inclusion requires not only personalized pathways, but environments that are generative of social productivity: spaces in which the diversity of individual trajectories is converted into collective richness through practices of collaboration, sharing, and the negotiation of meaning. From this perspective, evaluating the efficacy of inclusive instructional pathways cannot be limited to measuring the individual progress of each learner; it must include indicators of social productivity, the group's capacity to produce collective knowledge, to develop effective collaborative practices, and to build bonds of trust and reciprocity that transcend single individual pathways.

6. Conclusion

This contribution has proposed and developed a theoretical model the Human–Environment–Technology systemic triangulation, as an epistemological and operational response to the challenges posed by the entry of Artificial Intelligence into educational contexts. Departing from the diagnosis of semantic depletion produced by the algorithmic self, the model has outlined a conceptual framework capable of restoring centrality to the co-evolution between human, context, and technology, configuring learning as the production of socially shared and negotiationally constructed knowledge. The theoretical implications of the model touch upon fundamental questions of epistemological pedagogy: the nature of the educational act in the algorithmic era, the validation criteria of knowledge in contexts of increasing cognitive automation, and the role of critical agency as a condition of possibility for any authentic education.

The operational implications concern the design of instructional pathways capable of integrating the potential of algorithmic systems without sacrificing

the semantic depth of the educational experience. The perspectives for future research opening up from this model are manifold and articulated across multiple levels of scientific inquiry. On a purely theoretical level, there is a manifest need to further deepen the mathematical formalization of the hybrid ecosystem and its integration with advanced models of cognitive science and cybernetics. On an empirical and experimental level, it is necessary to design longitudinal research designs capable of testing the robustness of the model within real school and academic contexts, validating appropriate quantitative and qualitative observation tools suited to capture the complexity of triadic interactions (Mancarella, 2026). Finally, on a strictly operational level, it is urgent to translate the premises of the model into precise guidelines for the initial and continuous training of teachers, for the architectural reconfiguration of learning environments, and for the development of educational technologies that are structurally coherent with the principles of systemic triangulation, so that pedagogy may prove itself equal to the challenges of the contemporary transition. In the final analysis, the systemic triangulation model aims to found a pedagogy equal to the ontological transformation produced by AI: a pedagogy capable of preserving and developing what is irreducibly human within the educational experience – semantic depth, critical capacity, social productivity – precisely through, and notwithstanding, the technological mediations that characterize our time.

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