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Article

Systematization of Science and Innovation Activity from Communicative Interdisciplinarity: Methodological and Empirical Foundations of a Class Model as an Organic Totality

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Abstract

This article presents the systematization of results from the project “Communicative Interdisciplinarity” through the introduction of a system of 14 elective courses on the interdisciplinary class in Mathematics-Physics teacher training. It is demonstrated that the essential transformation of professional performance requires reconceptualizing the class not as an isolated outcome, but as an integrated organic totality. The experience, analyzed through a “complex model of systematization,” revealed patterns of self-similarity and recursivity in the instructional design, foreshadowing its subsequent theoretical formalization as a fractal and neuronal system. This systematization constitutes the indispensable empirical and methodological basis that underpins the development of integrated theoretical frameworks for education.

Keywords: systematization; interdisciplinary class; organic totality; teacher training; complex model; fractality; recursivity; Communicative Interdisciplinarity

1. Introduction: Praxis as the Origin of a Theoretical Model

Teacher training in the exact sciences faces a structural paradox: while educational problems are complex and systemic, training remains fragmented. From the Department of Physics-Mathematics at the Universidad de Oriente, this contradiction was addressed through the scientific project “Communicative Interdisciplinarity.” This work systematizes the implementation of a system of 14 interdisciplinary elective courses, whose central hypothesis was that transforming professional practice required a reconceptualization of the class itself. The objective is to present this systematization as the empirical foundation that, through a recursive reflective process, led to the discovery of the class as an organic totality—a principle later developed into a fractal-neuronal theoretical model (Barrera, 2025). This article thus constitutes Phase 1 (Praxis) and Phase 2 (Methodological Systematization) of a generative theory-building protocol.

2. Theoretical-Methodological Framework: Systematization as a Tool for Fractal Construction

2.1. The Complex Model of Systematization

The “complex model of systematization” (Barrera, 2011) was employed. This is a protocol that integrates reflection across four intertwined planes: practical, methodological, theoretical, and epistemological. This model allows treating experience not as anecdote but as raw material for scientific construction, operating as a recursive feedback loop.

2.2. The Class as an Object of Integration and Organic Totality

The class was defined as the fundamental “object of integration,” conceived from the outset as a complex organic totality where didactic components exist in dialectical relationships of mutual determination. This conception emerged as the central finding of the research.

2.3. Communicative Interdisciplinarity as a Praxiological Approach

This approach positions communication (language, collaboration, negotiation of meaning) as the constitutive fabric of the interdisciplinary pedagogical relationship, providing the concrete expression of the sought-after organicity.

2.4. Convergent Foundations: Fractality and Neuroscience

The viability of an organic totality model is supported by the convergence of two domains. On one hand, fractal logic offers an organizational principle of self-similarity and recursivity with precedents in educational design (Pérez & Ramírez, 2017). On the other, educational neuroscience provides the empirical substrate, with recent systematic reviews confirming the impact of strategies based on neuroplasticity, attention, and emotion on learning (Vargas-Tipula et al., 2024; Liu et al., 2025). The present work operates at the intersection of these domains, seeking a model that integrates them.

3. Experience and Systematization: Operationalizing a Fractal Design

3.1. The Course System as a Recursive Architecture

The design was initially structured around three operational axes: vertical (discipline), horizontal (academic year), and main integrator (central formative process). In analysis and systematization, this structure revealed its correspondence with a deeper logic of knowledge integration, later conceptualized as the disciplinary, interdisciplinary, and transdisciplinary levels. The latter, understood as integration that responds to the complexity of reality in ‘life,’ constitutes the space where the professional mode of action is fully formed and manifested. The 14 elective courses were organized following this logic. Their structure was not linear, but recursive: the product of one course (e.g., a diagnosis) became the essential input for the next (e.g., task design), in a spiral of increasing complexity.

3.2. Self-Similarity in Educational Practice

Structural self-similarity was observed at different scales. The logic of “node integration” to solve a problem in a 15-minute micro-activity replicated the logic for designing a complete subsystem of classes in a semester. The integrative task of each course functioned as a fractal of the total teaching-learning process.

3.3. Qualitative Impacts as Evidence of Emergence

The systematization allowed for the identification of impacts consistent with the emergence of a new systemic quality: a shift from the disciplinary to the interdisciplinary, increased collaboration, improved treatment of language, and greater relevance of work-research learning. These were not merely “positive results,” but observable indicators that the organic totality had begun to operate.

4. Results and Discussion: From Methodological Model to Theoretical Principle

4.1. The Emerging Methodological Model

The primary result of this systematization is a robust methodological model for designing teacher training, characterized by its recursivity, self-similarity, and orientation toward creating organic totalities in the classroom.

4.2. Organic Totality as a Generative Principle

The central discussion reveals that the effectiveness of the course system did not lie in isolated elements, but in having operationalized—even if initially intuitive—the principle of organic totality. This principle manifests as the fractal synchrony between instructional design, students' cognitive activity, and the group's communicative dynamics.

4.3. Link to Fractal-Neuronal Theory

This empirical finding is the necessary and logical bridge to subsequent theoretical development. The organic totality identified in praxis is precisely the phenomenon that the class model as a fractal and neuronal system (Barrera, 2025) comes to explain and formalize. Our approach shares the organizational principle with other fractal models but differentiates and deepens it by: (1) emerging from the systematization of a concrete praxis; (2) explicitly integrating the neurocognitive dimension from its most current empirical base; and (3) defining fractality not only as structure but as the recursive dynamics of classroom activity. The present systematization provides the indispensable empirical basis that validates and gives meaning to such theorization.

5. Conclusions

A formative experience has been systematized which, through a recursive and self-similar protocol, demonstrated the feasibility and superiority of approaching the class as an integrated organic totality. This praxis not only solved concrete training problems but acted as a natural laboratory where the principles emerged that would later demand a broader theoretical explanation. The concepts of self-similarity, recursivity, and fractal synchrony, operationalized here in curricular design, constitute the central methodological contribution and the most important legacy of this research phase. This work closes the cycle of methodological systematization and explicitly opens the door to theoretical systematization, which, by being founded on this evidence, acquires unusual solidity. The path taken validates the method: it is the fractal coherence between praxis, methodology, and theory-in-construction that ensures the transformative potential of the model.

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