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ARTICLE

INSURGENT SCIENCE TEACHING: ENVIRONMENTALIZING SCIENCE AND EDUCATION [1;2]

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ABSTRACT: The text corresponds to a critical review, whose first version substantiated analyzes and discussions related to field experiences produced in a qualitative research (SÁNCHEZ MOLANO, 2020) in school institutions in the periphery of a Latin American metropolis. Throughout the text, we will be accompanied by the Epistemologies of the South, whose main ideas give consistency to the argumentative thread, in relation to propositions about counter-hegemonic science, contemporary science, Latin American environmentalism and to the notion of ecology of knowledge, as well as to science teaching that can be anchored in those propositions. It advances in the understanding of the scientific practice from the postulates of epistemological pragmatism and methodological pluralism, which would be complementary to educational perspectives inspired by critical interculturality and insurgent environmental education. In the light of the foregoing, nomenclature revisions are proposed in the field of science teaching, more compatible with emancipatory perspectives projected from Latin America.

Keywords: Latin America; counter-hegemonic science; science teaching; critical interculturality; environmental weavings.

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ENSINOS DE CIÊNCIAS INSURGENTES: AMBIENTALIZANDO CIÊNCIAS E EDUCAÇÕES

RESUMO: O tecido textual corresponde a uma revisão crítica, cuja primeira versão fundamentou as análises e discussões relacionadas às experiências de campo produzidas em uma pesquisa qualitativa (SÁNCHEZ MOLANO, 2020) em instituições escolares da periferia de uma metrópole latino-americana. No caminhar pelo texto, estaremos acompanhados pelas Epistemologias do Sul, cujas ideias-força darão consistência ao fio argumentativo, em relação às proposições sobre ciências contra-hegemônicas, ciências contemporâneas, ambientalismo latino-americano e à noção de ecologia de saberes, bem como aos ensinos de ciências que podem ser ancorados nessas proposições. Avança-se na compreensão da prática científica a partir dos postulados do pragmatismo epistemológico e do pluralismo metodológico, que seriam complementares às perspectivas educacionais inspiradas na interculturalidade crítica e na educação ambiental insurgente. Com base no exposto, são propostas atualizações nomenclaturais no campo dos ensinos de ciências, mais condizentes com olhares emancipatórios projetados desde a América Latina.

Palavras-chave: América Latina, ciências contra-hegemônicas, ensinos de ciências, interculturalidade crítica, tecituras ambientais.

ENSEÑANZAS DE LAS CIENCIAS INSURGENTES: AMBIENTALIZANDO CIENCIAS Y EDUCACIONES

RESUMEN: El tejido textual corresponde a una revisión crítica, cuya primera versión basó los análisis y discusiones relacionadas con experiencias de campo producidas en una investigación cualitativa (SÁNCHEZ MOLANO, 2020) en instituciones escolares de la periferia de una metrópoli latinoamericana. En el recorrido del texto nos acompañarán las Epistemologías del Sur, cuyas ideas principales darán consistencia al hilo argumental, en relación con proposiciones sobre ciencias contrahegemónicas, ciencias contemporáneas, ambientalismo latinoamericano y a la noción de ecología de saberes, así como a las enseñanzas de las ciencias que pueden anclarse en estas proposiciones. Se avanza en la comprensión de la práctica científica desde los postulados del pragmatismo epistemológico y el pluralismo metodológico, que serían complementarios a perspectivas educativas inspiradas en la interculturalidad crítica y en la educación ambiental insurgente. Con base en lo anterior, se proponen actualizaciones nomenclaturales en el campo de las enseñanzas de las ciencias, más acordes con perspectivas emancipatorias que se proyectan desde América Latina.

Palabras clave: América Latina, ciencias contrahegemónicas, enseñanzas de las ciencias, interculturalidad crítica, tejidos ambientales.

WHY ENVIRONMENTALIZE SCIENCES AND EDUCATION IN LATIN AMERICA?

Despite the formal end of colonialism, coloniality strongly survives in subjective structures, imaginaries, and epistemological colonization (OLIVEIRA; CANDAU, 2013). We share with Santos (2006) the understanding that "social emancipation has three main dimensions: one epistemological, one theoretical, and one political" (p. 13, our translation). We understand, as the same author, that social injustice is based on cognitive injustice since the creation of privileged theoretical objects, such as technoscience, is linked to the social, political, and cultural empowerment of certain subjects and social groups and, consequently, to the marginalization of subjects and people who cannot appropriate these objects (SANTOS, 2003, 2008).

Therefore, thinking about decoloniality implies projecting democratization and contextualization of the processes of construction and appropriation of scientific knowledge in Latin America.

> The idea of coloniality concerns a process of domination in which relationships were established that prevent the dominated people from having their cultures recognized, access to universal

> science is denied, as well as from participating in political decisions, establishing social and affective bonds, and having human dignity respected (DUTRA; CASTRO; MONTEIRO, 2019, p. 2, our translation).

At the same time, we follow Hodson (2019), when he states that "the frequency in which environmental degradation impacts the poor, disadvantaged, and marginalized much more than the rich and powerful justifies the use of the term environmental racism" (p. 37, our translation). This environmental racism is particularly conspicuous in Nuestra América[3].

In a complementary way, we perceive that the characteristic utopia of contemporaneity is the environmental utopia. It corresponds to a utopia with the articulating potential of disciplinary fields, cultures, human dimensions, local resistance, and a diversity of past and current struggles. The realization of this utopia presupposes a radical exercise of citizenship aimed at the global transformation of modes of production, scientific knowledge, lifestyles, and social relationships (ethnic-racial, gender, sexual, family, labor, etc.). Therefore, it is a utopia that has no historical subject or privileged avant-garde (SANTOS, 1994).

Therefore, in this context, within the many emancipatory paths that still need to be woven by our people in Latin America, it becomes relevant to develop science teaching that faces the current configuration and consolidation of dogmatic, aseptic, ecologically irresponsible, socially and epistemologically unjust, of hegemonic science[4].

It is not a question of ignoring, rejecting, or demonizing the powerful disciplinary and symbolic constructions that were consolidated in modernity[5] and that today, to a large extent, sustain the current development model. It is not a question of denying reason and technoscience, but of irrigating them with ethics and passion, facilitating their appropriation from below, from the logic, desires, and needs of territories and communities, so that they have a counter-hegemonic use. In this regard, Santos, and Meneses (2009) state:

> Modern science has, for the past two centuries, been neither unconditional evil nor unconditional good. It is internally diverse, which allows her contradictory interventions in society. The truth is that it was and continues to be often appropriated by subaltern and oppressed social groups to legitimize their causes and strengthen their struggles (SANTOS; MENESES, 2009, p. 11, our translation).

This opinion is shared by Leff (2010) when he states that science and technology are not condemned to be exclusively supporters of wars, social injustices, and exploitation of nature. Technoscience is a double-edged sword, making it easy to see how the technological means generated at the core of neoliberalism present ambivalent political projections and, in many scenarios, are used as instruments of power and liberation by the oppressed.

In addition to the above, and taken by a deep sense of environmental justice (ecological, historical, cultural, economic, and epistemic), we are aware that the theoretical constructions of science, as well as the technoscience produced from them, were obtained and conquered over the struggles, efforts, blood, sweat and material and symbolic assets of all humanity. In this regard, Benjamin (2013, p. 23, our translation) comments that "cultural goods (...) owe their origin not only to the fatigue of the great geniuses who created them but also to the anonymous servitude of their contemporaries. There is no document of culture that is not at the same time a document of barbarism".

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[3] Name given by the Cuban poet José Martí to the portion of the American continent that goes from Rio Bravo in Mexico to Patagonia in Chile and which includes the Caribbean and its Antilles.

[4] We will use the terms technoscience and hegemonic science interchangeably. We believe that in contemporaneity, there are also counter-hegemonic sciences (agroecology, social technologies, collective health, for example) that pragmatically appropriate some technoscientific strategies and knowledge and combine them with other types of methodologies and epistemes as a function of what Boaventura de Sousa Santos has called Ecology of Knowledge, Enrique Leff of Environmental Rationality, and we will call environmental weavings.

[5] For Santos (1994), "Modernity provides many of the materials for the construction of the new paradigm. It just does not provide the architecture plan, or the energy needed to realize it" (p. 282, our translation).

We consider, therefore, that the appropriation, defense, responsible, collective, and fair use of these cultural heritages is a right of all people, without exception. Communities must claim their right to appropriate modern and postmodern science and technologies to improve their quality of life in harmony with their ecosystem assets (LEFF, 2010).

> Modern science is also part of the epistemologies of the South, insofar as it manages to dialogue in a tendentially horizontal manner with other, socially legitimate knowledge, promoting an ecology of knowledge. But, like other types of knowledge, it does not hold the status of the only valid knowledge (MENESES, 2019, p. 24, our translation).

This theoretical, methodological, but above all ethical challenge of decoloniality in education and scientific research in Nuestra América is expressed by Chaves (2013), when she states that all humanity has the right and the need to know the symbols and dynamics of scientific cultures so is not a passive user of technoscience. Thus, understanding its mechanisms and through the analysis of knowledge, interventions, and alternative practices, can be appropriated in a responsible, judicious, creative, and critical way.

It is common, in the daily life of our Latin American societies and their school contexts, for scientific culture to be seen as elitist, whose language appears foreign, untranslatable, and not palatable to the interests and desires of simple people. It stands out, in this way, being environmentally healthy that the people know the logic of scientific cultures and dominate their arguments critically, overcoming naive visions and conceptions that have been woven around scientific practices and that, many times, close them in castles crystal, isolating them from contact and feeling popular. Thus, an ideal of scientific practice would be projected into education, with socioeconomic benefits and risks better distributed, and human and ecological impacts and sacrifices avoided or reduced. This, indirectly, would also allow thinking about strengthening the scientific and technological capacity of the people and communities of the South and, in this way, obtaining independence from transfers and technological-political dominance of the North, promoting the endogenous and respectful use of ecosystem resources and ancestral-popular knowledge.

The environmental perspective would bring, to the teaching of science practiced in school settings in Latin America, urgent reflections on the meaning of producing and applying scientific knowledge in our territories and on the possibility of breaking with the instrumental and competitive model of thinking, teaching, and building science. From basic education onwards, alternative ways of producing other types of knowledge and subjectivation based on criteria that are more collaborative, solidary, and consistent with political and existential environmentalist ideas would be designed (REIGOTA, 2012).

Science education built from an environmental perspective would oppose the current hegemonic type of science teaching in Latin America, which continues to reproduce visions of science, education, the world, work, human beings, and society, based on individualism, marginalization of large contingents of human beings, and on the developmental assumptions of gross capital accumulation and unsustainable unlimited economic growth. Visions that are based on conceptions and attitudes castrate nature, reducing it to a simple passive, and inexhaustible source of material resources.

The anti-essentialist, interculturally critical, and transdisciplinary characteristics of the Latin American environmental perspective break with ontological metanarratives and dogmatisms, free education from disciplinary, epistemic, or cultural teleologies and foundationalism; they offer us the possibility of thinking about another type of teachers, schools, sciences, science teaching, scientists, more engaged, open and fluid. Science and education professionals whose practices and processes have a greater level of assertiveness in the desires, challenges, needs, and characteristics of this vast and colorful contingent of humanity that lives in Latin America.

Environmentalizing scientific practices and science teaching would once again allow them to be coated with that emancipatory aura that impregnated their birth in the Enlightenment against the dogmas of the Middle Ages, but this time, updating and directing their potential rebellion against the

groups of powers and micropower that they sadden life and reduce the diversity of senses, beings and ways of being. For Santos (2008a),

> It is not possible to imagine non-capitalist horizons within the exclusive framework of science; the fight against the capitalist system, which has guaranteed its hegemonic status thanks to science, requires a greater epistemic opening, in the sense of making visible fields of knowledge that the epistemological privilege of science has tended to neutralize and hide over the centuries (p. 152, our translation).

The environmental issue demands this epistemic openness and provides a sensual axiological inspiration, being a substrate and potent tool for the development of Science Teaching oriented towards collective good living, through the expansion of the symbolic universe of school actresses[6], aiming at dynamics of self-determination and self-management of the people and communities of Nuestra América.

CONTEMPORARY SCIENCES, COUNTER-HEGEMONIC SCIENCES, AND INTERCULTURALITY

Thinking about counter-hegemonic sciences, the environmentalization of sciences, or the construction of scientific practices and scientific education more consistent with the realities of Nuestra América, implies understanding the scientific field as a heterogeneous and dynamic field, which leads us to launch a quick look at the nature and sociology of science and the characteristics that this social practice has acquired since the last century.

In this way, we will get closer to the understanding of science and technology as human activities, historically and culturally determined, subject to different types of pressures and political interests. For Santos (2003), it is about understanding science as a social practice of knowledge, "a task that is carried out in dialogue with the world and that is, after all, founded on the vicissitudes, oppressions, struggles that make it up and to us, accommodated or revolted" (p. 13, our translation).

The path of the sciences takes place on and amid continuous and dynamic social constructions, in which they intervene producing new social constructions, capable of mobilizing forces and material processes that exist as a power in nature and society (LEFF, 2010). In the words of Lacey and Mariconda (2014), "scientific activities are not intelligible when separated from their socio-historical situations, the values embodied in them and their places in the world of life" (p. 643, our translation).

This perception of knowledge and disciplines as social constructions found support, according to Leff (2010) and Santos (2008b) when failures were identified at the very heart of the modern paradigm. The identification of these failures resulted from the great advances in scientific knowledge that the same modern paradigm promoted. In this way, its limits, its structural inadequacies, and the fragility of the pillars on which it is based were recognized.

In science, demonstrations have been produced that it is not possible to observe an object without interfering with it or changing it; that the laws of physics work only in a probabilistic way; that the whole is much more than the sum of its parts; that the subject-object distinction is not a discrete dichotomy but a continuous dispersion; that the proof of the consistency of any system is always external to it and that thermodynamic irreversibility happens to produce self-organization and systems that are the product of history. Thus, a perception of the world and knowledge was generated that breaks the objectivist and mechanistic view of a predetermined and fixed reality.

Thus, the passage from modern science to postmodern science is characterized, according to Santos (2008b), by a change in explanatory metaphors: "instead of eternity, history; instead of determinism, unpredictability; instead of mechanism, interpenetration, spontaneity, and self-

[6] By configuring this article as an explicitly political academic text, which considers different types of oppressions, we highlight its construction in the female genre. We know that it is the women in the global south that support the weight of environmental racism.

organization; instead of reversibility, irreversibility; instead of order, disorder; instead of necessity, creativity and accident" (p. 48, our translation).

Such metaphors invite us to understand scientific praxis more than as a reflection of reality, but as an instrument that transforms and builds realities, which becomes more palpable when we look at the characteristics of contemporary societies, in which the products of technoscience[7] are radically reconfiguring our realities.

> Science becomes technology; it no longer just observes, but penetrates the real, denaturing it, desubstantiating it, and technologizing it. The dualism between the concept and the reality of the relationship of knowledge that reduces the understanding of the world to that identity, which in the regime of rationality seeks the adequacy between nature and the idea, passes to that of the instrument that dissects, synthesizes, clones and explodes the core of Being between the same and the difference. The problem of knowledge changes to the effects of knowledge (LEFF, 2009, p. 264, our translation).

In this way, science acquires the potential to move from a mechanistic instrumentalism that has sustained capitalism and other types of developmentalism, to a pragmatism with emancipatory possibilities. Science produced under a contemporary paradigm with an emancipatory bias would be a workaround-knowledge[8], the product of an incessant search and recycling of alternatives in the deposits of domination that modernity has accumulated on its margins. Examples of these alternatives are found in agroecology, social technologies, sciences of other natures (De-Carvalho, 2020), and in the perspectives of preventive, public, and collective health.

> Agroecological practices amalgamate traditional agricultural knowledge with elements of modern science and technology, innovating practices that are culturally compatible with the rationality of peasant production. The resulting techniques are ecologically appropriate and culturally appropriate; allow to increase productivity and preserve the productive capacity of the ecosystem; preserve the planet's cultural identities and environmental services (LEFF, 2009, p. 384, our translation).

In his critique of instrumental rationality that denies other rationalities and knowledge and, therefore, promotes a waste of human experience, Santos (2009) tells us that no knowledge should be considered disposable or privileged per se. According to him, all types of knowledge and their hybridizations will be valued insofar as they are oriented towards an ecology of knowledge, which solves concrete problems of populations and designs alternatives to the great societal challenges.

For Santos and Meneses (2009), "the world's epistemological diversity, far from being something negative, represents an enormous enrichment of human capacities to confer intelligibility and intentionality to social experiences" (p. 12, our translation). From this point of view, it is possible to highlight two types of intercultural strategies that would give content to the ecology of knowledge.

First, we highlight the strategy that Santos (2004) calls intercultural translation, understood as the exercise of defining, in each moment or concrete historical context, the constellations of subaltern practices with greater counter-hegemonic potential. Through this type of intercultural translation, it becomes possible to identify common concerns, complementary approaches, and also intractable contradictions (SANTOS, 2010). This dialogic exercise between subaltern cultures, without cannibalization, would work as a counterpoint to the homogenization processes of neoliberal globalization.

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[7] According to Santos (2008a), in contemporary times, within hegemonic science, it is difficult to continue supporting the modern separation between science and technology which, according to the Portuguese author, was used for a long time to "affirm the intrinsic neutrality of science and assign the consequences of scientific research, desirable or undesirable, to its applications" (p. 146, our translation). This would justify the creation of the term technoscience to refer to that science that is hegemonic in contemporary times.

[8] According to Boufleur (2013, p. 7, our translation), workaround is the "act of improvising material solutions for utility purposes from industrialized artifacts".

The second strategy, which we will call anthropophagic interculturality[9], was inspired by Oswald de Andrade (1928) and the Brazilian Modernist Movement of the 1920s. We understand this intercultural dynamic as the judicious and critical appropriation of knowledge and hegemonic epistemologies, placing them in dialogue and contact with popular knowledge in terms of the desires and needs of the oppressed populations of the Global South.

These intercultural dynamics, which offer the cognitive substance of the ecology of knowledge, complement each other and express the sociopolitical meanings of what Santos calls Subaltern Cosmopolitanism. For Santos (2010), "subaltern cosmopolitanism is animated by a redistributive ethos, implying the redistribution of material, social, political, cultural and symbolic resources" (p. 47, our translation). It is also encouraged by the global awakening of environmental utopia, with its promising potential for articulating local resistance and emancipation (SANTOS, 1994).

Subaltern cosmopolitanism, according to Santos (2008b), develops from the exemplarity of the place, around themes that at a given moment are adopted by concrete social groups, such as territorial concerns. This would configure a new political paradigm "which conceives through imagination and generalizes through quality and exemplarity" (SANTOS, 2008b, p. 77, our translation).

This cosmopolitanism, working in an analogical and translating way, encourages locally developed concepts, theories, and practices to emigrate to other cognitive and experiential places so that they can be recontextualized and used judiciously.

> The knowledge of the Global South, anchored in the life experiences and struggles of people and communities, is not static; on the contrary, its diversity and specificity, in the contact zones, raise the need for translations between knowledge and practices, to carry out a fundamental task: to survive and (re)exist (MENESES, 2019, p. 25, our translation).

The ecology of knowledge, configured in the anthropophagic interculturality and the solidary intercultural translation, promotes the sustainable and dynamic interaction between the different types of knowledge, respecting the autonomy and contextual legitimacy of each epistemology, discipline, and/or culture. For Santos (2009), an ecology of knowledge is organized by understanding that:

> (...) all knowledge has internal and external limits. The internal ones concern the limits of the interventions in the reality that they allow. The external ones stem from the recognition of alternative interventions made possible by other forms of knowledge. The counter-hegemonic use of modern science is only possible through the parallel exploration of its internal and external limits (SANTOS, 2009, p. 49, our translation).

Neither anthropophagic interculturality nor solidary intercultural translation is relativistic. They have hierarchies between cultures, knowledge, and disciplines, because, according to Santos (2008a), "no concrete practice would be possible without such hierarchies" (p. 159, our translation). But these hierarchies are neither constant nor teleologically determined. They are transient, contextual, and axiologically oriented by the political principles of subaltern cosmopolitanism and, therefore, determined by the concreteness of the particular problem and the ecological and cultural substrates of the territories where interventions are carried out.

The intercultural dynamics that configure the ecology of knowledge are permeated by a pragmatic conception of truth, which, in the opinion of Santos (2003), is the only conception of truth that allows breaking with the circularity of reason and theory. This conception starts from the understanding that all knowledge is dynamic, plural, partial, and situated. Therefore, there are no pure cultures and knowledge, nor complete or eternal cultures and knowledge. Thus, the most correct thing would be to "compare all types of knowledge according to their abilities to perform certain tasks in social contexts delineated by particular logics" (SANTOS, 2008, p. 153, our translation).

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[9] According to Queiroz (2011, p. 2, our translation), for the Brazilian modernist anthropophagy movement would express a kind of totem: "Indigenous ritual celebrated for the strengthening of the tribe from the virtues of the defeated and dead enemy, it was the example of opposition, resistance and Aboriginal impassivity in the face of colonial invasion".

The pragmatic conception of truth focuses on the consequences produced by knowledge interventions in realities. The truth would not be a fixed characteristic, inherent in a given idea. An idea would be true insofar as it contributes to bringing about the events anticipated by it; therefore, in epistemological pragmatism, there is no definitive conception of truth (SANTOS, 2003). Thus, for Santos (2008a), "knowledge as an intervention in reality, and not knowledge as a representation of reality, is the measure of realism" (p. 159, our translation).

The contingent hierarchies between disciplines, cultures or knowledge would be organized around some criteria in which, according to Santos (2009), preference should be given to epistemological, methodological, and technological options, as well as to forms of knowledge that guarantee greater participation and well-being of the social groups involved in the conception, execution, control, fruition, risks and consequences of the intervention. We can deduce that the ecology of knowledge is ethically projected from subaltern cosmopolitanism and its values of participatory democracy, autonomy, self-management, sustainability, and social justice.

Hugh Lacey (2012), the Australian philosopher of science and technology, exposes an expanded perspective of science in which epistemological pragmatism and methodological pluralism[10] are implicit: "science thought of as systematic empirical investigation, sensitive to the ideal of impartiality, conducted through the use of any methodological strategies that are appropriate to obtain an understanding of the objects of investigation" (p. 425, our translation). Thus, according to this perspective, the knowledge that obeys logics and epistemologies different from those established by hegemonic Western science would also have fundamental relevance, insofar as they contribute to solving practical or conceptual problems.

Going a little deeper into his postulates, Lacey (2006, 2011, 2012) warns that currently, hegemonic science does not match its declared ideals of neutrality, autonomy, and impartiality, as technoscience generally works in a veiled way around perspectives of value which correspond to those of technological progress, capital, and the market. It ignores other perspectives of value, such as those of sustainability, social justice, and democratic participation, constituents of what we recognize as Latin American environmentalism and which would also be axiological components of subaltern cosmopolitanism.

Lacey and Mariconda (2014) state that the current discourse of currently dominant science has naturalized that the only viable strategies for scientific practice are those that serve to evaluate theories and hypotheses, through cognitive values: empirical adequacy, explanatory power, consistency, and coherence. However, if on the one hand, they enable to achieve effectiveness in the results of an innovation, on the other hand, they are blind to human, ecological and social contexts.

The fact that an innovation has effective results does not mean that the application of that innovation is legitimate. To assess the legitimacy of innovation, it is necessary to use strategies that are sensitive to contexts, which allows for determining the harmful side effects, and risks, generating the equitable distribution of its benefits, and comparing them with alternative methods to achieve similar results. These complementary strategies can be found in a broader range of sciences (humanities, social), in the arts, and popular and ancestral epistemes and knowledge.

Lacey, as a great connoisseur and friend of the emancipatory struggles in Latin America, defends the precautionary principle[11], understood as a strategy to broadly guarantee the ideals of

[10] For Santos (2003), methodological pluralism should not be confused with the methodological anarchism of Paul Feyerabend, nor with methodological eclecticism, because "unlike the first, it starts from a research logic that prescribes norms for the selection and use of the methods, and because, unlike the second, the same research logic limits the diversity between the methods used and establishes hierarchies" (p. 75, our translation).

[11] "The precautionary principle is more adequate to inform decision-making in situations in which questions about the risks of causing serious harm are raised, but ignorance or uncertainty prevails about: the details of the potential harm and/or its impact, and the probability that it would occur and when; and what is the potential of currently alternatives available" (LACEY, 2014, p. 689, our translation).

impartiality, neutrality, and autonomy, which hegemonic science has lost due to its subordination to mainly commercial values and military (LACEY, 2006).

To achieve these three ideals that science is openly proud of, the scientific practice requires the use of a plurality of strategies: both the classic ones, which only admit cognitive values, being sensitive to the structures and interactions underlying the phenomena or objects investigated, and those who are sensitive to socio-ecological contexts and who need ethical and social values in their analyzes and evaluations.

In his proposal for scientific practice based on multi-strategic research, Lacey also clarifies that context-sensitive strategies are complementary, not opposed to technoscience. They are a mechanism that would avoid distortions around the hegemonic perspectives of value and that capture aspects of phenomena that are not visible through technoscience strategies. Epistemological pragmatism and methodological pluralism would allow the researched phenomenon to be understood "not only in its structure, process, interaction, and underlying laws, but also associated with its human, social and ecological contexts" (LACEY, 2012, p. 427, our translation).

In this sense, Lacey (2011) states that "scientists' responsibilities also extend to deliberations on the legitimacy of applications of scientific knowledge" (p. 489, our translation). Consequently, the legitimacy of techno-scientific innovations should not be reduced to their instrumental effectiveness or their commercial potential, but evaluated based on the considerations that imply ethical and political judgments based on knowledge and strategies that are outside the logic and procedures of instrumental science. The ideas above become clearer and can be summarized in the words of Oliveira and Von Linsingen (2019):

> In many cases, Western Eurocentric knowledge is sufficient and adequate to meet the demands of society, but in other cases, especially when we are talking about historically marginalized groups, such as indigenous people, transsexuals, blacks, etc., scientific knowledge is inept, as it is not capable of helping these subjects to understand their reality and satisfy their needs, so that other knowledge and knowledge, local, ancestral, traditional, can and should be used (p. 187, our translation).

We perceive that the decision between the different types of intervention, in reality, is guided not only by cognitive judgments**,** but also by ethical and political judgments that materialize in values of responsibility, prudence, respect, and well-being (SANTOS, 2008). Therefore, the contingent hierarchies of the ecology of knowledge would depend on the context based on the results desired by the social actors involved and those allowed by the different epistemes. A counter-hegemonic science would incorporate the knowledge of communities into a participatory decision-making process in the social appropriation of nature (LEFF, 2009).

NOMENCLATURES AND OTHER COLONIAL DEMONS

We consider it necessary to open a parenthesis to clarify the use of the expression 'ecology of knowledge', which Santos (2008a) justifies as follows: "it is an ecology because it is based on the recognition of the plurality of heterogeneous knowledge, the autonomy of each one of them and the systemic articulation, dynamic and horizontal between them" (p. 157, our translation). From there, we will show our nomenclatural disagreement with the Portuguese author and propose the use of the expression 'environmental weavings'.

We noticed that the content of the Portuguese author's ecology of knowledge concept is similar to the meaning and brings the same ethical and political implications as the 'environmental rationality' concept of the Mexican Enrique Leff, in the sense that "in the ecology of knowledge, the search for credibility for the non-scientific knowledge does not imply discrediting scientific knowledge. It only implies its counter-hegemonic use" (SANTOS, 2009, p. 48, our translation). It is about exploring the internal and external plurality of science, that is, its limits and alternative practices and epistemologies.

We emphasize the need to establish, in the fields of environmental education and the teaching of "natural" and exact sciences, and in their communities of practitioners and researchers, clarity and consensus regarding the use of the expressions "environment", "nature" and "ecology", which currently continue to be used indiscriminately and loosely as synonyms.

From a decolonial perspective, the theoretical contents of these expressions are not similar, as they do not project the same empirical or conceptual objects. We perceive that the indiscriminate use of these expressions generates politically undesirable consequences in the practices and processes of environmental education, scientific education, and teacher training, as well as in the production of science and the construction of public policies in Latin America.

The term "ecology" has a solid theoretical and historical basis in the field of biology and natural sciences. Therefore, it is recommended that, in communities of practitioners and researchers in the fields mentioned above, this expression continues to be used preferably to refer to elements and dynamics that are framed in the field of knowledge referred to as biological, ecological, and "natural sciences".

Although some renowned Latin American environmentalists, in recent re-editions of their original works published in the last decades of the last century, use the terms ecology, nature and environment interchangeably, we argue that the indistinct use of these expressions does not reflect the profound epistemological advances and political events that have taken place in the fields of environmentalism and environmental education over the last three decades.

In philosophy, sociology, anthropology, psychology, history, economics, and other human and social sciences, the expression "ecology" (socioecology, ecossophies, ecology of knowledge, ecosocialism), with different nuances, is used as a metaphor. We adhere to the thinking of Santos (2008b) when he states that, in the new scientific paradigm that will emerge alongside a postmodern science, there will be a growing rapprochement between natural sciences and social sciences; but in the direction of the social sciences.

In contemporary times, metaphors brought from the social sciences, the humanities, and the arts will be increasingly considered in the transformation of the old scientific disciplines. The human and social sciences will increasingly distance themselves from the mechanistic metaphors of the Enlightenment or the biological and ecological metaphors of Darwinism and systems theory (SANTOS, 2008b; LEFF, 2009).

Therefore, we consider it a contradiction when the Portuguese thinker justifies the use of the expression "ecology" as a way of describing the "autonomy and systemic, dynamic and horizontal articulation between knowledge'", applying it to the political field of intercultural relations. This justification would be anchored in a false premise because, in the ecology of the natural sciences, the autonomies of beings are quite limited and the articulations between individuals are not horizontal.

In the ecology of biology, the degrees of freedom are smaller, and the articulations can be better understood as cyclical-systemic and little contingent. Furthermore, Santos (2008a), when characterizing the social sciences from the natural sciences, would be falling into a type of disciplinary or epistemological ethnocentrism, which the author, in his publications (SANTOS, 2003), invites to avoid.

We argue that the expression "ecology of knowledge", applied to intercultural contacts and dialogues, can be easily misunderstood, misrepresented, or instrumentalized to justify ecocentric ethics, ecological determinisms, reductionisms, or other types of teleologies. That expression does not represent the meaning and conceptual content of Enrique Leff's notion of environmental rationality, nor does it do justice to the theoretical and ethical network woven by Boaventura de Sousa Santos to give meaning to the emancipatory intercultural dynamics that would constitute subaltern cosmopolitanism.

We consider that bringing the ecological metaphor of the biological sciences to the fields of culture does not reach the political sense of the partial, concrete, situated, and transitory hierarchical relations between epistemologies, cultures, and disciplines that epistemological pragmatism and methodological pluralism defend. In the relationships between species, predation, extinction, and parasitism mark the "natural" flow of life. There, there are no oppressors, oppressed, rebellions, solidarities, or justice.

Therefore, we believe that education, marked by specific types of dialogues and intercultural encounters, and, in general, social relations, cannot be interpreted and read at the level of calibration of the conceptual sieves of biology or ecology. Ecosocial and intercultural relationships and processes have political, affective, and symbolic dimensions that escape through the interstices of these networks.

> Certainly, ecology can inform social action to internalize the ecological conditions of social organization and sustainable production; but this does not imply the need to green human thought and generalize this greening to explain social consciousness and political action (LEFF, 2009, p. 54, our translation).

Environmental rationality would become a more pertinent expression to describe the theoretical and ethical network that gives meaning to the emancipatory intercultural dynamics that constitute subaltern cosmopolitanism. The expression "environment" better represents and encompasses those symbolic and affective dimensions involved in intercultural, political, psychological, socioecological, and ideological processes.

So, we defend that "the different orders of the real are apprehended by specific theoretical concepts, not by the extension of the principles of mechanicism, evolutionary biology, and ecological systems to society" (LEFF, 2009, p. 57, our translation). When these principles are artificially and promptly taken to the social and human orders, they easily become skewed by the paths of conservatism and fascism.

Continuing the discussion, the concept of environmental rationality represents, according to Leff (2010), ethics that promote diversification, difference, and not a systemic, holistic, and totalizing integration of knowledge and/or cultures. In this way, knowledge is not closed in tautological circles (dogmas), but "continuously expands from theoretical resignifications on material processes and differentiated ontological orders", in concrete praxis (p. 212, our translation).

At this point, it is necessary to express a second semiological disagreement, this time with the expression Environmental Rationality, by Enrique Leff. Our disagreement revolves around two criticisms: 1. The expression rationality is used by this Mexican author in the singular, which may contradict his alleged interest in escaping from all holism and totality (would there be a single and all-powerful rationality or would there be multiple rationalities?). 2. Making the word rationality explicit can easily be misinterpreted as an exclusive or preponderant focus on the rational dimension, on the processes and emergencies of reason, ignoring or diminishing the flow of affective, magical, aesthetic, feeling-thinking aspects, so valued in the epistemes of Nuestra América.

After these necessary semiotic-nomenclatural clarifications, we consider that the denomination Environmental Weavings protects and better expresses the main ideas of the Portuguese and Mexican authors. The weavings express this diversity of practices, processes, and social movements, as well as their related theoretical, affective, epistemological, and pedagogical networks that are woven in Nuestra América, in which the sciences, the biosphere, symbols, affections, history, and emancipation are linked. At the same time, they give recognition to these beautiful ancestral practices, through which, in different fabrics (hair, wool, cotton, fibers, seeds, etc.), the cultures of Nuestra América give life and color to their existence and project their dreams, paths, and futures.

CHARACTERISTICS OF INSURGENT SCIENCE TEACHINGS

School communities and actresses in Latin American contexts and, mainly, in their urban peripheries do not present a homogeneous symbolic heritage from which we can establish a teaching prototype directed to a predefined target. In these colorful, dense, and complex scenarios, Science Teaching should not be projected onto a linear and transparent stage, but distilled from the boiling point of a growing trend of cultural hybridizations and translations.

Promoting, in science teaching, an indiscriminate deletion of alternative knowledge is to throw in the trash valuable experiences that survived in the cultural heritage of people, tested in the heat of everyday life. Environmentally woven, these experiences would help us to solve complex and concrete

problems and to work on understanding the great societal challenges from a non-hegemonic point of view. Thus, it is possible to propose, as a relevant contribution of Environmental Weavings to science teaching practices and processes, the political meaning offered to the pleasurable contacts between epistemes, disciplines, and diverse cultures, which would allow evaluations, hybridizations and contrasting, respectful and critical analyzes between the sciences and other types of knowledge and practices.

Also, the principles of Latin American environmentalism would enable us to overcome the narrow conception of the environment in which some currents of science education, through SSI (socio-scientific issues) and framed in the STSE movement (Science, Technology, Society, "Environment"), still work in Latin America. We believe that these pedagogical currents imported from "developed" countries need to be subjected to a deep, passionate, and low-fire, anthropophagic ritual.

Despite its criticality and its unquestionable contributions and developments in research and the practice of science education, the aforementioned movement continues to establish its models around a disciplinary colonial conception of the environment, which equates it with nature or the biosphere. This conception is exposed, for example, when the insertion of the "Environment" element in the Science-Technology-Society relations is justified as follows: "it is necessary to explicitly recognize the environment as an element in the relationship with STS, because the Environment, through its biotic (animals, plants, microorganisms, etc.) and abiotic (oceans, rivers, lakes, mountains, atmosphere, soil, etc.) components, for example, is the very condition of natural possibility for any society" (CONRADO; NUNES-NETO, 2018, p. 82, our translation).

As presented in the STSE movement, we perceive an "Environment" that acquires autonomy and independence from Science, Technology, and Society, and not that it encompasses them or that is implicit and constitutive of them. In this way, the Environment would be reduced to its biotic and abiotic components (excluding the social and historical), representing an element in interaction with the elements of Science, Technology, and Society, but exogenous to them. In this case, we consider that the concepts of biosphere or nature could better design those biotic and abiotic components of the environment. For us, the Environment is a political dimension with social, psychological, and ecological components that permeates the relationships woven between Cultures (sciences, societies) and Nature (biosphere).

We infer that the addition of the denominator E (environment) to the former STS (Science, Technology, Society) movement, in the 90s of the last century, was due to the global relevance of the environmental issue acquired after the Rio-92 Conference. However, the inclusion of the Environment factor in the STS movement acquired a sign of mere formality, as it lacked the due and profound ethical, political, and epistemological reflections that the environmental adjective implies. We consider that a denomination more in line with the Edenic, virginal, pure and ecological sense printed in the insertion of E in the STSE would be STSN (Science, Technology, Society, Nature) or STSB (Science, Technology, Society, Biosphere).

Furthermore, science teaching based on environmental issues would go further, even though they dialogue with science teaching perspectives philosophically located in a type of pragmatic pluralism, defended by authors such as El-Hani and Mortimer (2007) and Cobern and Loving (2001), that promotes a commitment to an ethics of coexistence between cultural differences in school practices. In these perspectives, science teaching understood as the transmission of a foreign culture is oriented towards the search for strategies that allow the understanding and mastery of the languages of science. In these types of culturally sensitive science teaching, the knowledge acquired in multicultural contacts is presented as a way of enriching the symbolic heritage of school actresses, adding to them more ways of interpreting and representing the world, facilitating a more dignified and pleasant navigation through the storms of life.

However, in these perspectives, the importance of politically questioning both the dynamics of scientific and popular cultures is underestimated. As an example, we can cite the valuable empirical work of El-Hani, Poliseli, and Ludwig (2022) on the nature of contacts between science and other cultures, in the sense that they recognize the dynamism, hybridity, and heterogeneity of every culture. In

addition, we can consider that its results aim to strengthen research programs framed in the cognitive aspects of what Enrique Leff (2010) calls Environmental Anthropology, understood as the search for the potential of popular knowledge and its possibilities of hybridization with scientific knowledge.

However, the authors recognize that, in their proposal of Partial Overlaps, the epistemic or cognitive aspects of interculturality prevail over the political aspects, which appear in a very timid way. We consider that proposals for cultural, disciplinary, or epistemic contact in which political aspects are little valued can lead us to logics of knowledge for knowledge's sake, or of interdisciplinarity and transdisciplinarity per se, and historical experience teaches us that these logics are easily instrumentalized by the hegemonic socioeconomic system.

Environmental Weavings enrich culturally sensitive science teaching perspectives, expanding them with meanings of social justice, and infusing them with emancipatory political potential, as they enable visualization, analysis, deconstruction and confrontation of power relations presented in discourses and social practices. In environmental weavings, questions concerning why, by whom, for whom, and how to establish contacts between cultures and epistemes are fundamental.

In this way, in science teaching, within the framework of cultural analysis, there would be a rupture with what Chaves (2013) names as liberal humanist multiculturalism, in which, according to the author, "one appeals to the notions of respect, tolerance, and coexistence between different, leaving untouched and unquestioned the power relations that maintain cultural, social and economic hierarchies between human groups" (p. 38, our translation).

On the other hand, following Souza Silva (2013) and Walsh (2013), in the Pedagogies of Good Living Collective or the Insurgent Pedagogies, the pedagogy is not limited to the instrumentalist sense of teaching and the transmission and aseptic appropriation of concepts. "Education is not an end in itself, it is a 'means-process' — of intervention in the formation of citizens — to reproduce a society, when its order is relevant to everyone, or to transform it into another society when its order it is violent, unequal and unjust" (SOUZA SILVA, 2013, p. 476, our translation).

In this direction, the Environmental Weavings in Science Teaching would also overcome the conformist inertia of the postcolonial concept of cultural translation (center-periphery intercultural hybridizations) defended by Hommi Bhabha (2002), advancing to the decolonial concepts of anthropophagic interculturality and translation intercultural solidarity, in which we consider politically more powerful.

This understanding leads us to perceive the theoretical foundations of InSURgent Science Teaching (IST) that are found, in the educational field, in the critical interculturality expressed by authors such as Mclaren (1997) and Candau (2013); in Latin American environmental education defended by Leff (2009), Reigota (2013), among others; and in the field of the nature of science, in epistemological pragmatism[12]and methodological pluralism in the lines of Boaventura de Sousa Santos and Hugh Lacey.

The IST make visible the inability of technical-scientific methods and strategies to fully understand and solve complex problems, such as environmental issues, and the need to combine them with other strategies, informed by other logic, and present in other disciplines, areas, and fields of the school curriculum. Multiple compasses, disciplines, cultures, and knowledge allow a greater level of rigor, integrity, and responsibility in the construction and application of knowledge (SANTOS, 2008).

These breaches of political work generated by AE insurgencies are an antidote against naive reductionism and scientistic dogmatism. Leff (2010) states that a non-reductionist view of the genesis, understanding, and solution of complex environmental problems always considers an articulation between physical, ecological, technological, and social processes, offering a preponderant place for the latter. Thus, Insurgent Science Teachings would represent educations that recognize technoscience as a powerful dominant culture, partially foreign, that could be cannibalized and placed in the physiologies, senses, needs, and interests of the people and cultures of the Global South. These efforts have been

[12] Unlike pedagogical perspectives based on liberal multiculturalisms, the critical epistemological pragmatism of Boaventura de Sousa Santos and the methodological pluralism of Hugh Lacey, taken to science teaching, offer ethical priority to the participation of communities in the construction of knowledge and in the transformation of realities, aiming at the self-management and autonomy of these communities, thus having a greater emancipatory political potential.

woven from the Latin American Thought on Science, Technology and Society, *PLACTS*, which, according to Linsinger (2007), proposes the promotion of scientific and technological knowledge linked to the economic and social development of Latin American countries.

Without the presence of ethics, militancy, and/or political activism, academic research and pedagogical action in science teaching become meaningless. We want to research, educate, and subversive sciences, and for that, we need ethical horizons, dreams, inspirations, and utopias that motivate us to walk, to follow ancestral footprints, that help us to awaken and strengthen the indignation and scattered hopes of the people. We need compasses that indicate our South, compasses that we have baptized as Environmental Weavings.

The Weavings make us recognize the crushing incompleteness of all knowledge, theory, or culture and, therefore, the impossibility of establishing a general and metaphysical hierarchy between forms of knowledge. Thus, science teaching would be designed around Environmental Issues, with all the political gain and the thematic and methodological opening that this epistemological change would imply.

Regarding the logistical aspects to develop IST, Amaral's work (2001) identifies different levels or styles of integration of the environment in science teaching. The Brazilian author points out that the development of these styles depends on the conceptions that the school actresses have about education, science, and the environment, as well as the administrative and organizational characteristics of the different school scenarios. For our purposes, we highlight the option for the project methodology, which would allow us to advance creatively and flexibly in the environmentalization of science teaching in an emancipatory perspective.

These projects would arise from the environmental problems that the school community experiences in its daily life, being articulated with relevant programmatic contents for its understanding and resolution, established in the study plans. Carrying out these projects would demand and encourage meetings between teachers from different areas, disciplines, and sciences, and between different members of the school and local community, which would highlight the inter and transdisciplinary meaning of environmental education. In school practices, science teaching-learning processes would be promoted in constant interdisciplinary and transdisciplinary dialogue with other fields of knowledge, with other human dimensions, and with popular knowledge.

Thus, science teaching-learning processes would be promoted from conceptual deconstruction, judicious criticality, cultural hybridization, and creative collective agency, based on a solidary relationship with territories and communities. Moving from affection to measurement and quantification, revisiting and reviewing bibliographies, mapping local knowledge, searching for memories and statistics, and combining experiences and experiments, this solidary relationship would necessarily pass to social activism and political engagement. The knowledge resulting from the environmentalization of science and science teaching would be prudent knowledge for a decent life (SANTOS, 2008b).

OPENINGS

We advanced in enunciating the principles and characteristics that would outline science teaching with an emancipatory profile, designed from the needs, desires, particularities, complexities, and potentialities of Latin America. Through dialogue with Latin American environmentalism, we show the nomenclatural limitations of the notions of the ecology of knowledge and environmental rationality, enriching its content with the incorporation of the notions of anthropophagic interculturality and environmental weavings. Also, we highlight the possibilities presented by an expanded understanding of the scientific practice through epistemological pragmatism and methodological pluralism to anchor science teaching based on critical intercultural perspectives.

In addition, we show how the transdisciplinary and anti-essentialist characteristics of Latin American environmental education make it a political tool for intercultural contact and, therefore, for transversalization and curricular territorialization. On the shores of Nuestra América, where intercultural contact is dense and vibrant, environmental issues could articulate and cross scientific knowledge with

popular knowledge based on everyday school and community problems, focusing on the analysis, prevention, and resolution of these problems. This environmental education anchors another paradigm of knowledge, a paradigm in which, through emancipatory contacts based on anthropophagic interculturality and solidary intercultural translation, popular knowledge is qualified and scientific knowledge is democratized.

It remains for us to continue walking through the schools on the shores of Nuestra América, through the schools in the quilombola, rural, indigenous, and urban periphery regions, mapping and dialoguing with their realities, languages, and practices; detail how the environmental issue is expressed in science teaching practices; develop a kind of environmental anthropology, identifying the potential of everyday knowledge to hybridize with scientific knowledge and inspire good collective living.

Also, it is pertinent to examine existing gaps in educational public policy documents and in their structuring projects to infiltrate the environmental dimension into science teaching curricula and practices. In Brazil, for example, through the qualitative research to which this article is articulated (SÁNCHEZ MOLANO, 2020), we realize that School Science Fairs, if built from environmental issues, problems or projects, can constitute privileged spaces for curricular transversalization and territorialization, a discussion that we intend to detail and develop in another publication.

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Author 1 – Data collection, literature review, data analysis, and text writing.
Author 2 – Research advisor, active participation in data analysis and review and organization of writing.

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