

Teaching Training for Science Teachers: From Self-formation to the Operationalization of Projects

This doctoral research examines the design and implementation of a continuing education course for science teachers focused on “Emerging Contaminants” and “Green Chemistry,” using a transdisciplinary approach. The study unfolded in four phases: (1) course design and material development; (2) presentation of the approach and collection of teachers’ narratives; (3) implementation of thematic activities with students; and (4) analysis of these activities and resulting school or community interventions. The methodology involved two scenarios: during the training course, teachers engaged in transdisciplinary self-training (hetero-, eco-, and self-education), with data recorded in a field notebook; and afterward, analysis of teachers’ narratives and student projects. Results showed that, although teaching strategies were similar, outcomes varied significantly. Teachers who applied a transdisciplinary approach helped students build more coherent, complex understandings. Most students partially succeeded in reconstructing concepts, while stronger results were linked to teachers who emphasized mediation over direct instruction. Additionally, student projects demonstrated potential social benefits. Overall, the findings suggest a strong relationship between transdisciplinary teaching, self-education processes, and the development of complex thinking and integrated knowledge.

Keywords: *Science teaching, Teaching-learning activities, Permanent and Continuing education.*

Theoretical Introduction

Recently, teachers from various fields have become interested in continuing education courses, both to develop new skills and abilities and to build knowledge about differentiated teaching approaches. Within this perspective, the theme of "Emerging Contaminants" (EC) and "Green Chemistry" (GC) was chosen as a motivating factor for the development of contextualized teaching materials, inspired by transdisciplinary approaches that serve as the foundation for a continuing education course for science teachers, as I stated in my doctoral thesis (Martins, 2020).

Initially, I questioned how EC and GC are situated in scientific, social, economic, and academic contexts. To this end, I sought to understand which contexts support them; what are the approaches related to their constitution and consolidation (ontological, epistemological, and scientific), the transformation of EC into a socioeconomic object, and their consequent appropriation as an educational (pedagogical) object.

ECs are a fundamental concept embedded in many discourses, especially scientific and technological ones (Pescara 2014; Montagner, 2014, 2018), and are almost imperceptible in school texts. Furthermore, this concept often appears

1 in texts that involve (1) political positions (environmental legislation and public
2 policies, for example), (2) social positions (anthropogenic factors related to
3 pollution and problems affecting public health), and (3) economic positions
4 (associated with the increased costs of treating water supplies, intended for
5 consumption, in relation to wastewater, for example).

6 In every discourse, there is a tension "(...) *between what is stabilized and*
7 *what is subject to equivocation, between the same and the different, between*
8 *paraphrase and polysemy*" (Orlandi, 1996, p. 31). Thus, it is possible that much
9 of the difficulty non-scientists have in understanding the scientific basis of ECs
10 is due to the fact that they are present in a wide variety of discourses, always
11 producing multiple meanings in different contexts (Lutfi, 1989; Silva, 2007). Let
12 us understand the contexts in which they are present.

13 **1. The ontological context** considers that contaminants, once inserted into
14 environmental compartments, become part of nature; this, in turn, constitutes a
15 system in which phenomena occur, substances interact, and processes develop.
16 Thus, changes in the composition of a given environmental compartment can
17 directly affect others, causing significant imbalances and effects/damage to
18 living beings present in the ecosystem.

19 This context considers that ECs are chemical substances; being material,
20 they are considered real objects, as ontological materialism advocates. The fact
21 that molecules are models that represent reality, however, can make
22 contaminants merely an illusory representation of truth, as ontological idealism
23 prescribes.

24 Environmental Chemistry can be considered a factual science, unlike
25 mathematics, which is a formal science. For Bunge (1985), factual sciences
26 verify (confirming or disconfirming) hypotheses that, for the most part, are
27 provisional. For this reason, it can be said that mathematical proof is complete
28 and final, while verification is incomplete and can therefore be temporary and
29 ambiguous.

30 Following Bunge's (1985) approach, it is argued that it is at this point—
31 relating to ambiguity—that we should value postmodern approaches. In
32 agreement with Morin (2013), the argument is made for the proper
33 problematization of errors, which are valuable learning tools and serve to reflect
34 on knowledge. Therefore, ambiguity constitutes an interesting avenue for the
35 construction of fundamental scientific concepts, such as emerging contaminants
36 (EC).

37 **2. The epistemological context** predicts that ECs constitute a relevant
38 object of investigation in Environmental Chemistry. According to Angotti
39 (1999), in the sciences, it is common to find objects of investigation that were
40 once considered neutral, determined, and closed, becoming (due to the
41 historical-social process, of which science is a part) non-neutral, interactive, and
42 open. In this sense, it would be possible to understand ECs, by their framework
43 within the structuralist approach, by establishing pairs of oppositional
44 characteristics (intrinsic and extrinsic to it) such as colonialism/solidarity or
45 order/chaos.

1 However, the historical-social movement experienced by humanity in the
 2 last half-century has highlighted the fact that these pairs of opposition do not
 3 allow explanations for many scientific concepts. Thus, the post-structuralist and
 4 transdisciplinary approach emerges, capable of proposing new paths (complex,
 5 indeterminate, and ambiguous) for science and its conceptual construction
 6 process. Similarly, science education is immersed in the emergence of
 7 technological innovations, to the point that contemporary content and methods
 8 are being developed and made virtually available—at least in theory—for all
 9 levels of education. For Delizoicov et al. (2002), research focused on learning,
 10 such as mental models and analogical and metaphorical reasoning, undoubtedly
 11 enriches the process of conceptual construction in science.

12 **3. The social context**, in turn, explains that we live in a largely capitalist
 13 society, controlled by consumption and the processes that ensure the production
 14 and reproduction of both. Currently, advertising campaigns are capable of
 15 generating demand by convincing consumers to buy what they don't need,
 16 transforming consumption into consumerism.

17 However, in the 1990s, many companies saw their profits decline
 18 significantly as they realized a decline in consumption caused by consumers
 19 demanding specific characteristics for certain goods: *green seals* (certificates
 20 given to suitable products that have a lower environmental impact), *ISO*
 21 *certification* (relating to product quality), and *sustainable production methods*.
 22 As a result, companies began to use green marketing to build an environmentally
 23 friendly image for a given brand.

24 As if these factors weren't enough, companies began to realize they could
 25 charge more for differentiated products; selling more of the same wasn't
 26 satisfactory. New formulations began to emerge in the pharmaceutical and
 27 cosmetics industries and, with them, new compounds were introduced into the
 28 environment: (a) without understanding the chronic effects caused by the
 29 residual concentrations found in the environment, (b) based on low-
 30 concentration active ingredients – which would require a greater quantity of the
 31 good to achieve the same effect as a so-called normal concentration, (c) without
 32 instructions for disposal and (d) under conditions that some compounds could
 33 result in even more toxic effluents and degradation products.

34 **4. The scientific context** explains that, in favor of ever-accelerating
 35 development, we transform knowledge into a commodity (Bauman, 2001). To
 36 escape this market logic, the reconstruction of society through the paradigm of
 37 citizenship is proposed, which legitimizes people's autonomy, with justice and
 38 equity. Thus, the need arises for the various areas of knowledge to engage in
 39 dialogue with each other, through a critical process that respects each of the
 40 positions assumed and guided by the democratization of scientific advances and
 41 the desire to put them into practice.

42 Science can enable students to "learn to learn" by establishing articulated
 43 ways of knowing, understanding, and representing the world and by providing
 44 the conditions for performing everyday tasks, since it is closely linked to
 45 technology. Since the 1980s, the ability to produce original knowledge has
 46 become an important differentiator for developing countries, which has led to

1 the accelerated growth of technical and scientific education. When it is suggested
2 that schools function as a privileged agency in addressing the issue of
3 knowledge, we must be mindful of the fact that we live in times of rapid
4 transformation, for which it is essential that the school community reflect on the
5 meaning of consensual discourse and pedagogical practices attributed to the
6 knowledge society. In contrast, this work suggests interpreting technical-
7 scientific discourses and practices from a transdisciplinary perspective.

8 **5. The pedagogical context** asserts that sustainable development and
9 Green Chemistry have characteristics that converge with the concept of
10 "knowledge-as-emancipation," as proposed by Santos (2006). For this author,
11 paradigmatic change is a process, harmonious in principle that involves the
12 exploration of resources and institutional changes, including the direction of
13 investments and guidance of technological development.

14 Thus, one of the ways to build new knowledge is through
15 experimentation, a method derived from the transdisciplinary approach that
16 begins with the voices of the students themselves, respecting their ways of
17 understanding the world, promoting the problematization of scientific
18 experiments based on the lived experiences of those involved in the
19 teaching/learning process (T/LP), and helping students give new meaning to
20 science by building concepts aligned with complexity (Morin, 2001), one of the
21 foundations of transdisciplinarity.

22 These contexts helped the researcher/advisor answer the following
23 research question: *How do Science teachers, who completed a continuing*
24 *education course, describe the implementation of a series of classes as part of*
25 *the program of that course?*
26
27

28 **Research Scenarios**

29
30 I developed the research methodology based on two research scenarios:

- 31
32 • In the first, during the teacher training course, I explored the three phases
33 of transdisciplinary self-training with teachers, problematizing their
34 positions regarding hetero-training, eco-training, and self-training,
35 collecting data in a field notebook;
- 36 • In the second, I analyzed teachers' narratives and positions, based on the
37 analyses and results obtained from thematic activities and work
38 projects—facilitated by the teachers and developed by their students—
39 that are part of the final course assignments.

40
41 The theoretical conception of the continuing education course for science
42 teachers was based on the premise that most of them—due to the use of rigid
43 teaching materials and rigidly determined durations (lesson taught; lesson
44 studied) by school administrators—used traditional teaching methods based on
45 the transmission-reception model (Freire, 2005).

1 Believing that traditional teaching concepts, often disconnected from
2 learning, no longer address the complex problems of today's world, a continuing
3 education course for science teachers was proposed. The objectives of this
4 course were: 1. To reflect with teachers on the possibility of including
5 transdisciplinary and postmodern aspects in the teaching/learning process; 2. To
6 consider the use of emerging contaminants (EC) and green chemistry (GC) as
7 research subjects; 3. To evaluate the possibility of teachers developing, together
8 with their high school students, thematic activities and work projects related to
9 the didactic perspectives present in the previously written instructional material;
10 4. To foster the training of teachers who, using complex thinking, construct and
11 disseminate connections regarding EC, their (potential) effects, and (actual)
12 harm to the environment and the health of living beings.

15 **Research Methodology**

17 To answer the research question, a research methodology was chosen that
18 was developed—though not defined—over the course of a year of research
19 (2018). The research question required a rigorous methodology, intertwined with
20 a postmodern perspective, and that demonstrated feasibility for analyzing a
21 complex object through transdisciplinarity.

22 To understand what contributions transdisciplinarity could bring about
23 transformations and/or advances in the continuing education processes of
24 science teachers (using CE as the research object), a structured investigation was
25 conducted in four phases:

26 (1) Development and problematization of teaching materials by the
27 researcher/advisor (2018). A continuing education course was structured, as well
28 as instructional materials aimed at pre-service teachers, which were constantly
29 discussed with the advisor, a role I played.

30 (2) Application of the material in a continuing education course for science
31 teachers (first semester of 2019). In the second phase, the transdisciplinary
32 approach was contextualized and presented to the educators participating in the
33 training course, recording their narratives about the teaching materials and their
34 problematizations.

35 (3) Development of thematic activities by the teachers/educators in their
36 respective classrooms, using a transdisciplinary-inspired pedagogical approach,
37 as well as their problematizations by the researcher/advisor (2019). In the third
38 phase, the teachers proposed thematic activities to their students and collected
39 data relevant to the teaching/learning process.

40 (4) Analysis of the articles and critical assessments produced by the
41 teachers, as a tool for evaluating the continuing education course, and the points
42 of convergence and divergence regarding the concepts constructed and discussed
43 during the continuing education course (2019/2020). In this phase, teachers
44 carried out analyses of the proposed thematic activities, particularly the results
45 of the mediated discussions and interventions proposed at the school
46 (community) level through work projects.

1 Despite criticisms of qualitative research, particularly regarding its
2 empirical and sometimes subjective nature, this type of investigation has well-
3 defined characteristics, such as:

4 1. *Objectification of the phenomenon*: Pedagogical phenomena are
5 configured as a complex product of a relationship, with none that can be
6 considered simple from an analytical point of view; the object is not freely
7 apprehended through immediate experience, but constructed, implying
8 knowledge incompatible with the certainties promised by objectivity;

9 2. *Hierarchical organization of the acts of describing, understanding,*
10 *explaining, and specifying the relationships between the global and the local*:
11 This research focuses primarily on the analysis of the positions of those involved
12 in the FIC course and their students; In it, the aim is to understand the positions
13 by describing, classifying and interpreting them, which can enable the analysis
14 of the relationships in each of the areas involved, taking into account global and
15 local aspects, and resulting in their hybridization, through the formation of the
16 concept called glocal (= global + local);

17 3. *Respect for the interaction between the objectives pursued by the*
18 *researchers, their theoretical orientations, and their empirical data*: Research
19 should be treated as a whole, in which the data collected, the collection
20 processes, and their interpretation respect the researcher's theoretical orientation.
21 Furthermore, there is an interaction between the data, the processes, and the
22 researcher's systemic vision in the pursuit of their goals;

23 4. *Seeking more reliable results*: Because of this, one must constantly seek
24 the processes for verifying the collected data and problematizing them. It is not
25 enough to obtain texts produced by students in the classroom; After the delivery
26 of the materials, a questioning process should be undertaken to ascertain: (a)
27 what was actually accomplished and what was planned, (b) what was discussed
28 and what instructions were given to the students during the classes (both those
29 of the FIC course and those of the educators in the classroom) and (c) how the
30 teachers constructed their texts and their speeches, ensuring that there is no
31 reinterpretation on the part of the educator (with alterations in the way the
32 students narrated their position and how the educators interpreted what the
33 students said);

34 5. *Opposition to a single research model for all sciences*: although this thesis
35 work deals with a scientific research object (emerging contaminants), the
36 scientific method should always be questioned, since it may not account for all
37 of reality. It should be clarified that the aim is to interpret the actions and
38 reflections of educators, relating them to the transdisciplinary approach and the
39 postmodern perspective, from the preparation of activities (by educators) to their
40 textual production, in the form of articles or other genres, including critical
41 analysis, and going through their performance in the classroom.

42 In order for the qualitative research to have its precepts respected, initial
43 exploratory studies were carried out, which were tested. After these tests, the
44 research was initiated and the first theoretical connections were built, after the
45 analysis of the empirical data obtained. Since this research also aimed to identify
46 the relevant factors that contribute to understanding the role of emerging

1 contaminants and the potential danger they represent to living beings, this
2 investigation added an explanatory character, by shedding light on the factors
3 that lend themselves to the construction of the concept related to emerging
4 contaminants.

5 From a scientific point of view, qualitative research advocates a holistic
6 view of phenomena, and is therefore of great value to transdisciplinary studies.
7 This type of research, when addressing scientific aspects, takes into account both
8 the analysis of the research object (emerging contaminants) and aspects related
9 to the interactions of these and their products of metabolism with other
10 substances, as well as the reciprocal influences (synergistic or antagonistic)
11 between substances and the environmental compartment in which they are
12 found.

13 14 15 **Results: Presentation and Analysis**

16
17 The article produced by the educators who completed the continuing
18 education course, and the notes in the field notebook made by the
19 researcher/supervisor, resulted in important analytical tools, since they allowed
20 for the comparison of the results obtained by the educators in their thematic
21 activities and what they actually built in the course. In this sense, it is stated that
22 these two moments, in which I was directly involved as a researcher/supervisor,
23 constitute points of great relevance for the analysis.

24 Sixteen teachers enrolled in the continuing education course. Of these, six
25 dropped out at the end of the first month, and the others participated in practically
26 all the classes of the training course. However, only three of them submitted the
27 final text and, therefore, constitute the research subjects.

28 To test the educators' level of understanding, a brief conversation was held
29 before each class of the course began to contextualize the subject. This type of
30 attitude was repeated by the educators in their high school classrooms before the
31 start of the thematic activities. In the training course, the researcher/supervisor's
32 intention was always to investigate the educators' conceptions and practices
33 regarding science teaching.

34 Still in the inaugural class of the training course, the general lines of the
35 research were presented. In this meeting, the educators signed a declaration in
36 which they agreed to participate in the research and that they freely and
37 spontaneously granted their texts for analysis. The researcher/supervisor would,
38 in return, guarantee anonymity to them, as well as to the schools in which the
39 thematic activities would be applied.

40 Throughout the training course, nine activities were carried out and, at the
41 end of these; the educators had to produce summaries of the individual thematic
42 activities. The educator was free to choose the textual genre to be used, giving
43 them the freedom to express themselves through articles, videos, technical
44 activity reports, etc. This summary of thematic activities would be evaluated by
45 the researcher/supervisor and, together with the other evaluative activities,
46 would help to compose the final grade of the course.

1 The perception of levels of reality enabled teachers to develop
2 transdisciplinary practices aligned with complexity and based on a plurality of
3 ideas, languages, and resources. To this end, throughout the continuing
4 education process, the aim was to (1) practice teaching with sensitive listening,
5 (2) maintain a cooperative, dynamic, supportive, and intellectually welcoming
6 environment, (3) respect the positions of each of the agents, so that this respect
7 culminated in the formation of collaborative ties and enabled the socialization of
8 results, discussions, and problematizations.

9 In mediating the debates in the FIC course, the relevance of guiding work
10 teams to plan, prepare, and execute more open activities, and of carrying out a
11 continuous analysis of the investigative question, problematizing it or even
12 redefining it, was demonstrated, at least in part.

13 Through the use of the educational perspective of project-based work and
14 associated with the pedagogy of integrated knowledge, it was problematized and
15 discussed that the proposed projects, to a certain extent, not only welcomed
16 alternative conceptions, notably those that motivated teamwork, but also
17 reflective actions, which made the agents realize how ambiguity can be used in
18 favor of knowledge construction and which provided debates among the agents,
19 challenging them to use their cognitive skills and to build more robust models
20 that gave meaning to their experiences.

21 Regarding the rigorous and clear dissemination of results, I believe it was
22 possible to create a continuous demand among teachers for the problematization
23 of meanings, for the multiplicity of interpretations, and for the construction of
24 more precise statements. It was also possible to observe that although there is no
25 single way to respond to the demands of the project, it was possible to establish
26 a consensual meaning that determined a response to – not the end of – the
27 research project. As could be observed in the speeches of each of the teachers
28 who completed the training course, education and science provided their
29 students with: the ability to build scientific knowledge, to become aware of their
30 complex identities; to transform the human condition (explosion of hunger and
31 poverty, lack of housing and minimum working conditions) into an object of
32 study for all teaching by situating the individual in the Universe, making him an
33 object of study, while at the same time being the subject of it.

34 In addition to the textual summaries, educators were asked to produce an
35 instrument, called Critical Rescue, in which they would summarize: (1) the direct
36 results of their experiences; as well as (2) the possible changes in their
37 pedagogical paths, (3) the transformations in their classes and (4) the new
38 knowledge built in Science, (5) evaluating the successes and failures of the
39 course and (6) the performance of the researcher/supervisor.

40 Critical Rescue, in the socio-educational context, is applied to value the
41 memories and productions of specific groups, enabling the rescue of memories
42 (using the genre to work on personal accounts, often focusing on the experiences
43 of communities or individuals, as in school projects) and conceptual re-
44 signification, with the offer of classes on reading and writing that aim to rescue
45 the voice of individuals, using literature as a tool for reflection and criticism.

1 The Critical Rescue process led the teachers who completed the continuing
2 education course (FIC) to assume an active posture of reading and analysis, when
3 collecting material, investigating and transcribing texts, understanding them as
4 an expression of a personal or social culture, analyzing the context of production.
5 Going beyond description, Critical Rescue also proposed an important
6 reflection, based on the reader's cultural background, establishing links between
7 the reader and the analyzed text. The ultimate goal of Critical Rescue is to allow
8 text production to become an active social activity, and not just a grammatical
9 exercise.

10 All the instruments described were used as material for analyzing the work
11 of the researcher/supervisor and as relevant pieces to evaluate the proposed
12 teaching material, the teaching-learning processes and the continuing education
13 course it.

14 The analysis and discussion of the data obtained in the four phases
15 demonstrated that, although the teaching/learning strategies used by the teachers
16 were similar, the results were quite distinct; revealing that the teachers who used
17 the transdisciplinary approach managed to build, together with their students,
18 concepts more aligned with complex thinking.

19 Thus, it is possible to affirm that: (1) from a pedagogical perspective, most
20 students achieved success, albeit partial, in the construction (or reconstruction)
21 of concepts related to the thematic activities; (2) from a self-formation
22 perspective, the most significant results were achieved by students who
23 contributed positively to the process, associated with teachers who focused on
24 mediating the teaching/learning process instead of conducting it; (3) in the social
25 sphere, success was achieved by developing work projects with the potential to
26 bring benefits to society as a whole.

27 28 29 **Final Considerations**

30
31 This work concludes that there is a direct relationship between the results
32 obtained by the students, the self-learning process, and the use of the
33 transdisciplinary approach by educators, which notably aided in the development
34 of complex thinking and the reconnection of knowledge.

35 As shown above, the analysis and discussion of the narratives involving the
36 educators' productions – both the activities carried out during the training course
37 and those that emerged from their final articles, used as an evaluative instrument
38 for this course – demonstrated a mismatch between what was suggested to the
39 teachers to apply in the classroom and what they actually did. A more in-depth
40 analysis of the students' productions – both the answers presented in the debates
41 held in the thematic activities and those resulting from their work projects –
42 revealed that the students' motivation was much more linked to academic results
43 (grades) than to human development.

44 Even with difficulty, three of the teachers endeavored to use the logic of
45 complex thinking; however, the results obtained were modest, since the teachers
46 focused their attention only on the construction of concepts specific to their

1 curricular components, as the considerations and problematizations of scientific
2 concepts constituted obstacles to an understanding of complex phenomena. On
3 the other hand, it was found that the self-training process of the teachers was
4 successful, providing elements that broadened the analytical vision of the
5 teachers, helping them to operationalize their thematic activities and to
6 problematize the students' questions.

7 The students, in turn, understood that if people started demanding
8 increasingly specific products, they needed different formulations and, in that
9 sense, incorporated new substances into those already available. In a way, the
10 teachers and some students were able to understand that EC, despite being
11 "potentially dangerous," deserve due attention regarding their danger.

12 It was concluded that, for now, the victims are potential. The concentration
13 of ECs to which people are exposed is thousands of times lower than that of the
14 pollutants that caused victims in Bhopal (1984), and their effects may take a long
15 time to appear. The fact that emerging contaminants are many times persistent
16 and act on the endocrine and neurological systems of living beings implies that
17 the concentrations considered safe for exposure to ECs may be exceeded in the
18 near future.

19 To defend against this situation, measures must be taken to eliminate ECs,
20 such as expanding the treatment of wastewater (sewage). Unfortunately, current
21 consumption patterns only reinforce the entry of current emerging ECs into the
22 environment, either through improper disposal of materials containing them or
23 through the discharge of untreated sewage and effluents into water bodies. In
24 addition, approximately two thousand new substances enter the market annually
25 as a result of current consumption patterns.

26 According to Martins and Montagner (2018), the fact that the risk of death
27 caused by emerging pollutants is still potential, coupled with the extra cost of
28 instruments and reagents, leads companies responsible for water treatment to
29 delay the implementation of processes that eliminate emerging pollutants. But
30 the relevance of the topic demonstrates the urgent need for public policies aimed
31 at controlling, treating, and possibly eliminating emerging pollutants, and which
32 should act on at least three fronts:

33 (1) in the training of conscious and informed consumers about emerging
34 pollutants, that is, individuals aware that their own consumption patterns
35 generate some of the emerging pollutants and that they should not panic when
36 any of them are detected in the environment;

37 (2) in holding accountable those who do not control their effluents
38 (industries) and those who are negligent, especially those who should treat
39 sewage and water supplied to the population;

40 (3) in the creation of a regulatory framework that would determine
41 procedures and standards for the treatment of water made available to the
42 population, with specific targets for the short, medium, and long term.

43 It should be clarified that it is not possible to base the establishment of a
44 framework aimed at the common good of the population on the fear of business
45 owners (of transferring part of their profits to the public treasury due to the
46 payment of hefty fines) and managers (of losing their freedom due to

1 administrative errors). Political negotiation with the various sectors of society
 2 seems to us the most appropriate way to establish an effective process for water
 3 treatment. Regarding the population, fear of emerging contaminants should not
 4 be instilled in them; rather, it should be shown that respect for the environment
 5 must supersede excessive consumption patterns and lead to the conscious
 6 disposal of waste.

7 According to Martins and Montagner (2018), the history gives us good
 8 examples of collective panic generated by news broadcast on radio (“The War
 9 of the Worlds,” broadcast by CBS in 1938, with Orson Welles as narrator) or
 10 television. Similarly, the conclusions of certain scientific works, without due
 11 clarification, can be misinterpreted by readers.

12 An alert about the dangers associated with EC, detached from its context,
 13 does not escape this reality: it can exacerbate debates, based on erroneous
 14 interpretations of the subject, and even frighten people, by overestimating the
 15 dangers attributed to emerging contaminants –that emerged in a more recent
 16 phase of the Anthropocene, created to combat public health problems, including
 17 “new diseases,” resulting from the evolution of pharmaceutical research, and
 18 inserted into a “market logic” that combines high profitability and large-scale
 19 consumption.

20 In answering the research question, we conclude a journey that began some
 21 years ago and is inexorable, depending on the desire of the one who walks it;
 22 There will always be new directions that are not exclusively scientific/
 23 pedagogical, but interweaving educational, technological, epistemological,
 24 environmental, social, and human health-related aspects, among many others to
 25 explore.

26 To travel these new directions, we can use transdisciplinary and postmodern
 27 "vehicles" focused on integrated knowledge or work projects, in which the
 28 ignition is provided by the research question and which uses, as fuel, the desire
 29 to teach and research. The complex routes would not exclusively involve
 30 science, but could use facts and data on emerging contaminants and green
 31 chemistry (our research object) to understand the historical-environmental
 32 process, and also systematize knowledge.

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