

Methodology of Trees and concept maps: paths that integrate and articulate Environmental Education and Science Teaching

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Abstract. The Environmental Education, believing on the break-up the unsustainable ways of being and doing in the world, on valuing natural diversity and community, on democratizing knowledge and making decisions for and with the collective, requires pedagogical practice that allow the action of the subjects involved, with space for their previous understandings, proposition of actions and systemic understanding. In this work we make theoretical considerations about the Methodology of Trees and the concept maps as paths that integrate and articulate the pedagogical doing in Environmental Education. The Methodology of Trees contributes to understanding the environment, identifying conflicts and planning related actions with sustainability. Concept maps favor the understanding of complex issues, the identification of concepts and contents, as well as their interrelationships through a systemic approach. The combination of these ways contributes so that the pedagogical practice in Environmental Education is based on collective dialogue and knowledge, contextualized, interdisciplinary and meaningful.

Key words: Teacher training, environmental education, science teaching, methodology of trees, concept maps

Introduction

Environmental degradation, as a result of the unlimited use of natural resources, is not new and is linked to a developmental concept that seeks profit and exploitation, not only environmental but also human. The unlimited and disoriented extraction from nature with the purpose of generating wealth for minorities (distribution is unequal), and the exploitation of human labor to obtain more profit, are some of the actions affecting the environment. In the opposite direction of this context, some groups have been discussing and claiming for educational ways to transform our relationships with the environment. Thus, the critique of the established social models and the ecological movements that problematize the forms of domination and exploitation of nature, contribute to the emergence of the concept of Environmental Education.

In order to conceptualize Environmental Education in its complexity, it is essential to have a broad understanding of what the environment is, since perceiving the environment as nature is only one of the understanding possibilities. Sauv  (2005) argues that considering the environment as nature to appreciate, respect and preserve is a gap that needs to be overcome. According to the author (2005, p. 317) "it is necessary to rebuild our sense of belonging to nature, to

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this flow of life in which we participate", it is necessary to deconstruct the human-nature dichotomy.

In this perspective, the author proposes a more comprehensive notion to conceptualize the environment, "the environment is the fabric of life itself, where nature and culture meet; the environment is the crucible in which our identity, our relationships with others, our 'being-in-the-world' are forged" (Sauvé, 2005, p. 317). The systemic understanding of the environment along with the fabric woven by education, transformation and critique of current social models, contributes to the understanding that Environmental Education: "is not, therefore, a "way" of education (an "education for...") among countless others; Is not simply a "tool" for solving problems or managing the environment" (Sauvé, 2005, p. 317).

In this way, Environmental Education is not only a field of education and not just a field of conservation. Environmental is not supposed to qualify education as an adjective. Environmental here is a noun. "The environmental attribute [...] constitutes an identity trait of environmental education, marking its origin in a determined historical context: environmental social movements and their horizon of countercultural criticism" (Carvalho, 2002, p.85). Therefore, interdisciplinarity is closely linked to the proposal and objectives of Environmental Education, regarding the democratization of knowledge and the collective construction of relevant knowledge that may result in changes in the relationship and attitude of humans to the environment.

From this perspective, some questions emerge: How to articulate Environmental Education and Science Teaching? How to implement pedagogical practices that contribute to sustainable actions? How to promote Environmental Education in Science classes? Which methodological paths integrate and articulate Environmental Education and Science Teaching? Thinking about strategies to articulate and integrate Environmental Education and Science Teaching is to conceive methodologies and didactic resources that contribute to pedagogical practices that opt for this way.

In this paper presents the Methodology of Trees (Crivellaro; Neto; Rache, 2001) and concept maps (Novak, 2002; Novak, 2010) as a possibility of articulation and integration of Environmental Education and Science Teaching. Environmental education, even in school education cannot be thought and carried out only as a theoretical field, it is increasingly urgent that the learning subjects assume and recognize their social and environmental responsibility in the contexts of which they are part, and in this sense, the Methodology of Trees contributes to understanding the environment, identifying conflicts and planning actions that contribute to sustainability. Whereas concept maps contribute to the systemic thinking of contexts, concepts and content, producing interdisciplinary relationships between them.

Methodological paths that integrate and articulate Environmental Education and Science Teaching

Environmental Education and Science Teaching bet on breaking unsustainable ways of being and doing in the world, in terms of valuing natural and community diversity, democratizing knowledge, making decisions for and with the collective, proposing alternative ways of production and relationship with the environment, enhancing subjects' autonomy. The educational processes in line with these perspectives need to be associated with methodologies and teaching resources that enable and enhance the action of the subjects involved, giving space for their previous understandings, action propositions, and systemic understanding. In the following subsections, each methodological path will be presented to subsidize the enunciated understandings.

Methodology of Trees

The Methodology of Trees (Crivellaro et al., 2001) was created and proposed in the context of Environmental Education in teacher training actions, and with the perspective of educational work through projects, based on identification of conflicts and search for solutions. This Methodology is in line with the pedagogical proposal of Critical Environmental Education, since it contributes "to the development of individuals and social groups capable of identifying, problematizing and acting in regards to socio-environmental issues" (Carvalho, 2004, p.19).

In order to start the development of the Methodology of Trees, an Environment Study is carried out (Crivellaro et al., 2001), which must be done in two moments: by the proponent of the methodology and by the group involved. The person who proposes and enables the development of the Methodology of Trees should construct their own perception about the context in which they will act as mediator, and have subsidies to carry out the following steps, not by giving answers or inducing the participants, but in order to mediate it is necessary to understand the environment. There is no script to be followed in order to conduct the Environment Study, but some elements to be observed and pointed out are suggested: landscape, biome and water resources; native and exotic species of community fauna; native and exotic species of community flora; agriculture and community farming model; fishing and fishing models; culture (clothing, dances, cures, religiosity, leisure, typical food, music...); groups and collective organizations present or active.

Observing such elements makes it possible to understand and identify the environmental vocation of the place where the methodology will be developed, that is, identify which human activities (social, cultural and economic) harmonize with the natural characteristics of this environment. In a second moment, the Environment Study is done with the participant group, through a potentiality assessment - what does the place and context where I live have that is good? (Crivellaro et al., 2001). The potentiality assessment is done first, in order to contribute to local valorization, because it is common to focus on problems and groups often get surprised by how much potential the context where they live has. Then, conflict assessment is done - what problems does the place and context where I live have? The Environment Study is one of the elements that contributes to the understanding of the Methodology in the context of Critical Environmental Education, which according to Sauv  (2002) is associated with processes of understanding environmental, social and educational contexts in order to transform them, considering the specific characteristics of the population and the context in which it develops.

Based on the elements of the Environment Study, the participant group is encouraged to mention the potentialities and conflicts of its context. This way, the study produced is done according to the perceptions, experiences, and practices of the participating group (therefore, it is not pre-determined, and thus different potentialities and conflicts can be listed for the same context when working with different groups). It is important that the assessment of potentialities and conflicts be prepared on a board or space that is visible to all. Afterward, the same space and materials may be used to develop the trees, so that the participant group itself can draw and write on the trees.

To start the construction of the conflict tree, it is necessary to organize the indicated conflicts along with the group. Organize in terms of grouping similar conflicts, or including the more specific ones under a major conflict. Through a dialogue, the group chooses a conflict to "look into", in order to solve it, or chooses to split into subgroups to develop trees of different conflicts.

Once the conflict is established, the tree begins to be developed. The main conflict determined by the group goes

on the trunk. Then, the group thinks about the causes of this conflict, so that they are placed on the roots of the tree. This is another difference of the Methodology, since it enables the community to be the subject of the environment diagnosis, and allows the community itself to identify the causes of the conflict. Layrargues (2002) points out that many activities and actions of Environmental Education are focused on the effects of human actions, and thus end up giving more emphasis to effects than causes, which does not contribute to significant changes in perception and action.

Back to the development of the conflict tree, the consequences of the conflict for the environment are written on the branches, how does the conflict affect the studied environment? In this sense, Carvalho (2004, p.21) points out that one of the purposes of Critical Environmental Education is:

Promote the understanding of socio-environmental problems in their multiple dimensions: geographical, historical, biological, social and subjective, considering the environment as a series of interrelations established between the natural world and the social world, mediated by local and traditional knowledge, besides scientific knowledge.

The multiple dimensions and interrelations of the natural and social world are shown in the conflict tree, and contribute to the prior identification of the themes and concepts of Science Teaching, and also to develop the solution tree in a systemic way. Once the conflict tree is finished, the solution tree is developed. It should establish a direct relationship with the elements present on the previously developed tree. The solution for the conflict situation is placed on the trunk of the solution tree. Then, along with the group, an ends assessment is made, that is, what is achieved and what is desired with this resolution, which will form the branches of the solution tree. Finally, the roots of the solution tree are determined, what the means are, the actions the participating group can implement to achieve the ends.

Choosing actions to resolve the conflict situation is a process that requires a lot of discussion. It is the most delicate step, in which the participants are mobilized to carry out actions of change, actions that can be effectively implemented by the group. Thinking and proposing the roots allows the group to be involved in "[...] solving or improving these problems and conflicts through teaching-learning processes [...] that advocate a meaningful construction of knowledge and the development of an environmental citizenship" (Carvalho, 2004, p.21). The proposal and call made by the methodology is that, instead of blaming or holding others responsible for the conflict and current situation, they can see themselves as co-responsible and active participants of the environment to which they belong. When looking for solutions, it is essential to recover the list of potentialities in order to reconcile the solutions with possible partnerships (groups and collective organizations), cultural activities and the environmental vocation of the place. Another difference of the Methodology of Trees is proposing work in the collective, breaking with the idea that: "[...] social change will happen through the sum of individual changes: when each one does their part" (Carvalho, 2004, p. 20) and, at the same time, with the idea that the responsibility for change belongs to society, as if it were an external element to each person.

Conflict and solution trees, developed by students in a science teacher-training course, are presented below to illustrate the discussions in the article. In this activity, the students developed the Methodology of Trees as a proposition for a countryside community group. The development of the trees was carried out considering the problem of inadequate management of water resources in a rural community in the south of Brazil. The trees can be seen in Figure 1.

DISEÑO DE TRAYECTORIAS HIPOTÉTICAS DE APRENDIZAJE

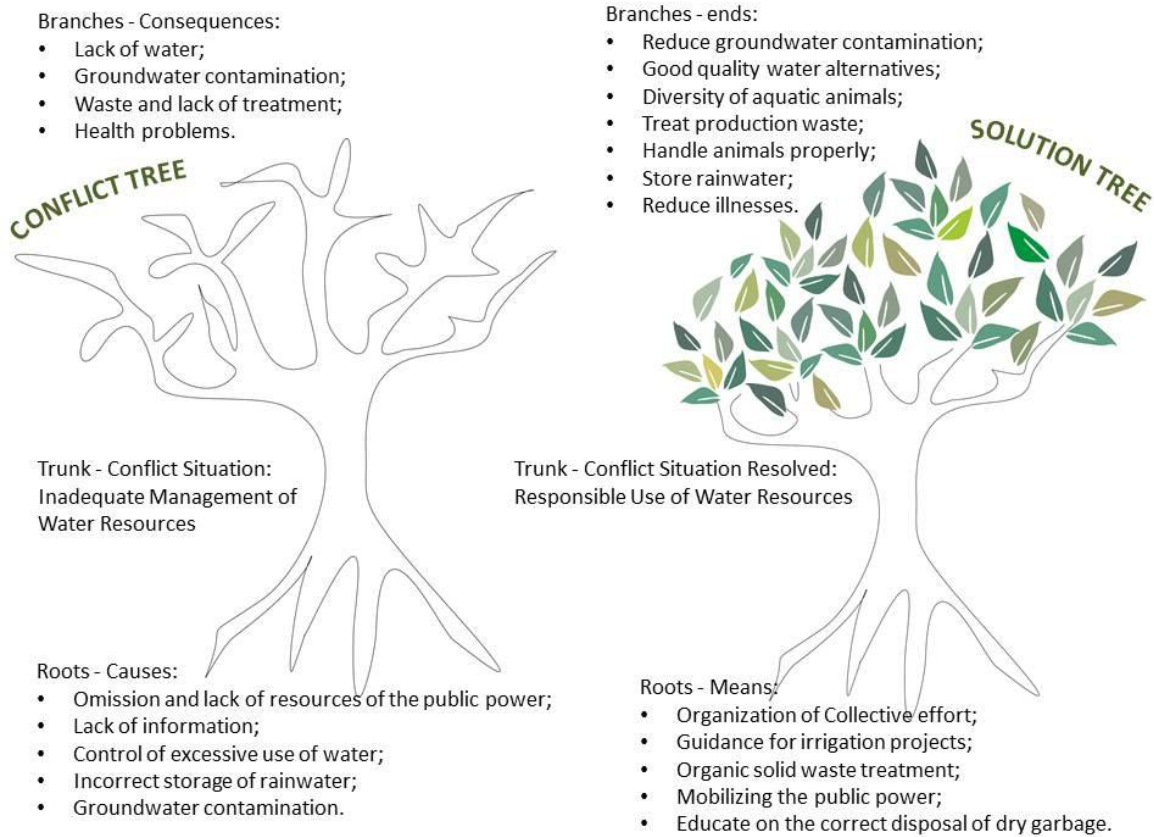


Figure 1: Conflict and solution trees developed as a proposition for the inadequate management of resources in a rural community in the south of Brazil.

The last step of the Methodology is to transform the Trees into an environmental intervention plan, in order to integrate the identified elements and allow the proposed actions to be part of a process. To develop the plan, they should simply correlate the elements according to the following Table 1:

Table 1: Correlation between trees and composition elements of the environmental intervention plan.

CONFLICT TREE		SOLUTION TREE	
Root	Introduction	Trunk	Main goal
Trunk	Project Main theme / problem	Branches	Specific goals
Branches	Justification	Root	Methodology and activities

It is possible to observe that after the cognitive challenges made possible by the construction of the trees, the development of the environmental intervention plan is simple and shows another difference of this methodological proposal. The Methodology is also in accordance with the "Diretrizes Curriculares Nacionais para a Educação

Ambiental" (Brazil, 2012) (National Curricular Guidelines for Environmental Education), since it allows subjects to experience Environmental Education in a way that stimulates an integrated view, critical thinking, appreciation of diversity; contribute to the recognition of the natural environment, review of school practices, responsibility toward the various forms of life and construction of planetary citizenship; promote observation and study of nature, projects and pedagogical actions that include cultural and environmental appreciation and diversity, experiences that include the production of scientific knowledge. Thus, the Methodology of Trees, through the analogy of a tree's constitution and interrelation (root, trunk and branches) contributes to the systematization of conflicts and solutions, to their systemic, interdisciplinary and integrated perception, and to a didactic-pedagogical mediation in the collective.

Concept Maps

Concept maps can be defined as a set of concepts immersed in a network of propositions (Novak, 2002; Novak, 2010). Propositions differentiate this graphic organizer from other similar ones, such as mind maps (Davies, 2011). Propositions are semantic units that carry a message and consist of two concepts (initial and final), a linking term, and an arrow indicating the reading direction (Novak, 2002; Novak, 2010).

Because of these characteristics, the concept mapping technique allows an explicit description of idiosyncratic mental models. These models are internal (cognitive) representations of ideas, events, objects or systems used in the generation of external representations. They come from a modeling process that continually involves the review or rejection of some phenomenon or system. External representations of mental models not only represent the conceptual understanding of the mapper, but also the ability to think systemically about complex problems, such as environmental problems (Brandstädter; Harms; Großschedl, 2012). In this sense, Vekiri (2002, p.283) argues that graphical displays, as concept map:

can be processed more efficiently than text, which allows them to support cognition in complex tasks. They can function as memory aids, enabling viewers to have access to information without maintaining it in working memory, guide cognitive activity, and facilitate inferencing during problem solving (Vekiri, 2002, p.283).

Environmental Education focuses on teaching and learning complex matters that sometimes challenge human understanding (Palmer, 2002). Therefore, it is essential to stimulate critical thinking through a systemic approach, that allows the integration of different areas of knowledge, in order to educate citizens capable of dealing with such matters. This approach emphasizes the relations between scientific and technological knowledge and, at the same time, social, economic and political influences (Thomas, 2009; Tsui, 2002).

Concept maps can be used separately or combined to articulate pedagogical practices that lead to Environmental Education. To illustrate this combination, a map was present (Figure 2) with the content that emerged from the conflict and solution trees in Figure 1.

When such methodological paths are developed in a combined way, the articulation of Environmental Education with Science Teaching is increased, as in the example presented throughout the article. Thus, from a contextualized problem - the inadequate management of water resources - not only its consequences, but also its causes are identified. Furthermore, it allows the proposition of actions in line with Environmental Education, which contribute to solving the problem. By creating a concept map from the trees, it is possible to highlight concepts connected with the theme, and based on these concepts, plan activities related to the school curriculum in the scope of Science Teaching.

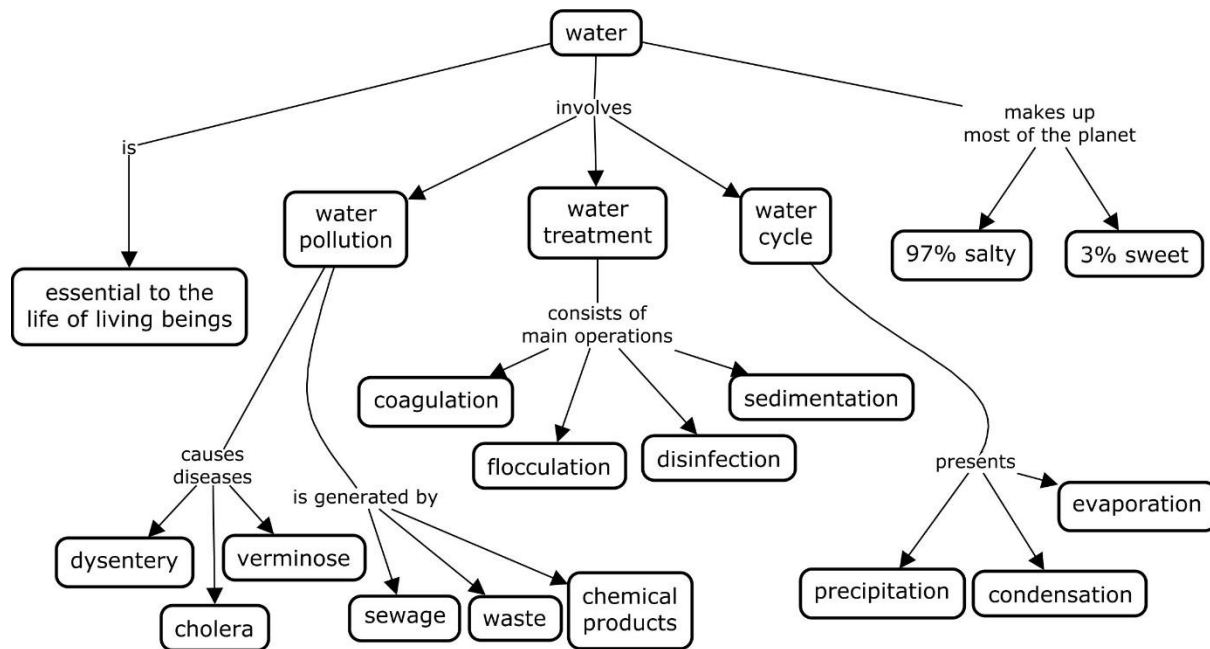


Figure 2: Concept map created from the trees in Figure 1.

Considerations on the combined use of the Methodology of Trees and concept maps

In this work presents considerations on the Methodology of Trees and concept maps as methodological paths that integrate and articulate the pedagogical doing in Environmental Education. Figure 3 shows a concept map that systematizes the main ideas of this article.

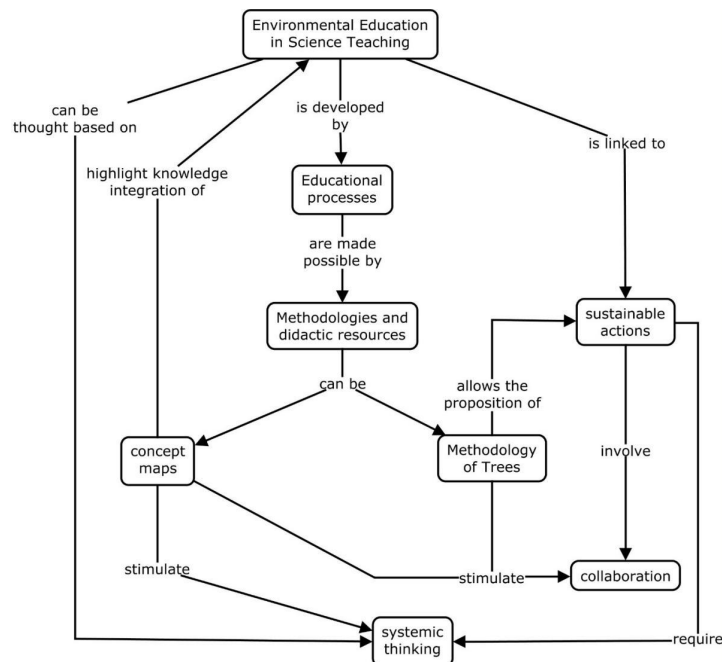


Figure 3: Concept map - the combined use of the Methodology of Trees and concept maps in the pedagogical doing of Environmental Education.

Based on the developed concept map, we can systematize the contributions of these pedagogical strategies in their combined use. The Trees contribute to determining concrete and contextualized themes in Environmental Education, and based on this practice it is possible to create concept maps that show systemic relations using Science Teaching concepts and content. Thus, the combination of these paths assists the teaching activity by relating concepts and content. It contributes to the possibility of pedagogical doings that lead to contextualized, interdisciplinary and meaningful sustainable actions, based on dialogue and collective knowledge. It also increases the autonomy of the subjects involved, providing space for their previous understandings, action proposition, and systemic understanding.

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