v. 3, n. 30, 2023

International Journal of Human Sciences Research

RELATIONS SCIENCE, TECHNOLOGY AND ENVIRONMENTAL PROBLEMS: EDUCATION CONTRIBUTIONS TO SUSTAINABLE DEVELOPMENT IN SCIENCE/CHEMISTRY TEACHING

Lucimara da Cunha Santos
Distance Education Center,
``Universidade do Estado de Santa Catarina`` – CEAD/UDESC
Florianópolis – SC
http://lattes.cnpq.br/7969241877680459

Rejane Maria Ghisolfi da Silva
``Universidade de Passo Fundo`` – UPF
Passo Fundo – RS
http://lattes.cnpq.br/0430203502306626

Abstract: This work was presented at the III CIECITEC - International Congress of Scientific and Technological Education, held from June 10 to 12, 2015, at `` Universidade Regional Integrada de Alto Uruguai e das Missões``, on the campus of Santo Ângelo, in Rio Grande do Sul, Brazil. The research aimed to analyze what Science teachers say about the relationships between science, technology and environmental problems, as well as to investigate the possible contributions of the ESD approach in Science teaching, especially with regard to the establishment of these relationships. For this, the records contained in the Virtual Learning Environment of an extension course in the distance modality with face-to-face activities were scrutinized. This course was offered by the Center for Distance Education, at ``Universidade Estadual de Santa Catarina``, for teachers of Basic Education Sciences in the city of Florianópolis, Santa Catarina, Brazil. The records of licensed professors in Chemistry and graduates of the course were analyzed, which allowed us to make some considerations. The professors considered the role and challenge of science and technology in solving and preventing environmental problems, as well as the importance of the contributions of Education for Sustainable Development to the teaching of Science, especially for the establishment of relationships between science, technology and environmental problems.
Keywords: Teaching Science/Chemistry; Relations between Science, Technology and Environmental Problems; Education for Sustainable Development.

INTRODUCTION

In facing the different and complex environmental problems, different discourses linked to the different sociocultural spheres circulate.

Some state that science and technology can help in the mitigation and prevention of environmental problems in order to solve them. Others accuse science and technology of causing many of these problems. There are also those who understand "science and technology, simultaneously, as part of the problem and part of the solution, that is, they are risk creators, but are also indispensable for the detection and mitigation of their harmful effects" (LIMA, 2011, p. 31).

There is consensus on the need for and dependence on scientific and technological knowledge for the development of societies. For this, it is necessary to learn to read and understand science and technology, much more than watertight concepts, their implications and consequences, in order to be able to participate consciously and informedly in political and social decisions (BAZZO, 1998).

According to Chassot (2000) scientific literacy can be understood as a set of knowledge that facilitates citizens to read the world they live in, so that they can transform it, preferably for the better. The term that Chassot (2000) calls scientific literacy, is also called by other authors as scientific literacy, or even literacy, translated from English *literacy*.

Within this context, the institution of the United Nations Decade of Education for Sustainable Development (DNUEDS) declared by UNESCO for the period 2005 - 2014, added to the efforts to promote a scientific education that integrates the foundations of the concept of sustainable development (SD), given the need to overcome the perverse effects of environmental degradation and the worsening of extreme poverty in the world (SCHMIDT, 2011).

In this sense, several actions were and are being considered, in order to integrate the proposals of Education for Sustainable Development (EDS) in the training processes. This has represented a challenge for teachers

and training institutions, being the object of constant allusion in investigations, debates and policies that deal with socio-environmental and educational issues (FIEN & TILBURY, 2002; FREITAS, 2004; HOPKINS & MCKEOWN, 2005, 2007; MCKEOWN & HOPKINS, 2002; PEDROSA, 2003; VILCHES et al., 2011; SANTOS, 2014).

However, such discussions, in general, have had little resonance in the context of formative processes. Although there is consensus among teachers on the need to include the subject in the curricula, namely in Science teaching, few initiatives are put into practice, others seem to be ineffective.

Therefore, commitment is needed to enhance learning in Science in the sense that students can be introduced "to the ideas and practices of the scientific community and make these ideas and practices meaningful at the individual level". (MORTIMER et al., 1999, p. 33). Such ideas and practices include knowledge about science, technology and environmental issues in a contextualized way and related to the demands of society. This way, the question arises: *Do science teachers establish relationships between science, technology and environmental problems? Can education for sustainable development contribute to establishing these relationships? Does the establishment of these relationships favor the teaching and learning process of content related to science, technology and environmental issues?*

In the search for answers to such questions, the present work aims to analyze what Science teachers say about the relationships between science, technology and environmental problems, as well as to investigate the contributions of ESD in Science teaching, especially with regard to the establishment of these relations.

METHODOLOGY

The methodological approach of this investigation according to the nature of the data is of the qualitative type, and, according to the sources of information, it is characterized as a case study. Case study "is a research category whose object is a *unit* that is analyzed in depth" (TRIVIÑOS, 1987, p. 133). However, this unit is not isolated, but is part of a larger context that needs to be considered in the analysis. The case study guides the reflection on a scene, event or situation, producing a critical analysis that leads the researcher to make decisions and/or propose transforming actions for that situation, event or scene.

The universe of the research took place in the city of Florianópolis, Santa Catarina, Brazil, with a group of licensed teachers in Chemistry and graduates of an extension course in the distance modality with face-to-face activities as participants. This course was offered to Science teachers (graduated in Biology, Physics and Chemistry) and Geography in the city of Florianópolis, and is part of the actions of ``Universidade Estadual de Santa Catarina`` within the scope of the DNUEDS, as well as in favor of the integration of knowledge related to environmental issues in the processes of initial and continued training of teachers who work, or will work, in Basic Education in the state of Santa Catarina.

According to the documents contained in the virtual learning environment (AVA) of the extension course, this "is based on a new perspective of education, which allows preparing teachers, students and other citizens to understand the complexity and interdependence, the causes and the consequences of the environmental crisis". In addition, it proposes "a new conception of education" that allows educators, planners and managers in the field of education to acquire "new skills for the conception, implementation and evaluation of educational experiences

and forms of organization that, involving a broad participation of the people involved, contribute to building more sustainable societies".

For data collection, reflective journals (individual) and discussion forums (collective), which make up the course VLE, were used. The texts for analysis were selected based on the questions raised about environmental problems and ESD that were part of the reflections and activities proposed during the course.

For the process of organizing and analyzing the collected data, we used: "[...] a set of communication analysis techniques that uses systematic and objective procedures for describing the content of messages" (BARDIN, 2004, p.. 38). This set of analysis techniques makes up the so-called "content analysis" proposed by this author. The corpus analyzed was divided and organized from the teachers' records on environmental problems and on ESD.

DISCUSSION OF THE RESULTS

The discussion of the results of the analysis carried out was organized, according to the study questions, being structured in two categories: i) relations between science, technology and environmental problems; ii) Education for Sustainable Development.

RELATIONS BETWEEN SCIENCE, TECHNOLOGY AND ENVIRONMENTAL PROBLEMS

There has been a consensus in the scientific community that the majority of environmental problems result from the imbalance caused in large part by human activities. These imbalances are perceived in different dimensions of natural systems – lithosphere, hydrosphere, atmosphere, which make up our biosphere. This way, due to the complexity of the problems, knowledge of the most varied areas is required for their mitigation and solution. If, on the one hand, we are witnessing the progressive depletion of natural resources (renewable and non-renewable), as well as difficulties in managing the waste produced by society (large open-air dumps), on the other hand, emergency measures need to be adopted.

In the analysis of the environmental problems pointed out by the teachers, the following stand out: *climate changes; global warming; extinction of animals and plants; fuel burning; extraction of products from plants; industrial Revolution; greenhouse gas emissions; emission of polluting gases; improper disposal of garbage; depletion of non-renewable natural resources; waste of energy; production processes and modes of consumption; political and economic interests; Lack of planning.*

A great breadth and diversity of cited environmental problems can be observed, indicating that teachers relate environmental problems with the different dimensions of society - economic, ecological, political and cultural, mainly. It can also be inferred that they have a broad view of environmental issues, relating them to scientific and technological development. According to the teachers, the environmental problem is not something recent, but it can be considered that since the oldest and most remote civilizations, even in prehistory, such problems have always been present, intensifying during and after the Industrial Revolution. Teachers also consider that the development of technologies can generate negative environmental impacts due to their misuse, although they consider the importance of scientific and technological development to improve people's quality of life:

> "The cause of degradation has its origins in prehistory, when man discovered that he could improve the taste of food with the use of fire or when extracting medicines from plants, which at that time led to an

International Journal of Human Sciences Research ISSN 2764-0558 DOI 10.22533/at.ed.5583302317085

> improvement in his quality of life. The cause of degradation begins with the machine revolution, the industrial revolution. (...)" (PROF A)

Another aspect highlighted by one of the professors is related to production and consumption systems, which, for him, are strongly associated with increasing environmental degradation.

> "(...) The unbridled consumption of substances, materials, energy, resources, directly reflects on the generation of environmental problems. (...) It is notorious and indisputable that a large part of society lives dependent on science and technology, without often problematizing its mode of production, the effects caused to health and the environment and even its real consumption needs. (...)" (TEACHER B)

Professor B's statement suggests that dependence on science and technology establishes a direct relationship between production and consumption. Most of the investigated professors consider individual action to be important in favor of a healthier environment for all, indicating awareness as an important action strategy for mitigating and preventing environmental problems.

> "(...) each individual increases their contribution to a healthier environment for all. (...)" (TEACHER C)

> "I believe that the search for its solution, remediation or even (and preferably) its prevention, must go, initially, through individual actions, of awareness/action." (TEACHER B)

The reflections contained in the two clippings above point to the need to understand the environment as a collective space of multiple interactions and interrelationships between the individuals who are part of it, and between them and the environment. Therefore, individual actions are reflected in the common space that is shared by everyone, everyone being individually and collectively responsible for everything that happens in the environment they live in.

According to authors such as Capra (2001), the systemic view or conception as a method to analyze environmental issues is fundamental in understanding many phenomena that occur in different natural and artificial, rural and urban ecosystems. By overcoming the Cartesian or mechanistic and reductionist view of classical physics, without wanting to underestimate its importance for the development of science, modern physics brought as its main contribution, the questioning about "the classical ideal of an objective description of nature, but also challenged the myth of value-free science" (CAPRA, 2001, p. 81). The Cartesian view, contrary to the systemic view, is based on a linear model of progress, where social development is a consequence of scientific and technological development, based on the perspective of the neutrality of science and technology, without considering the social and environmental impacts of science and technology.

EDUCATION FOR SUSTAINABLE DEVELOPMENT

Education for Sustainable Development (EDS) is configured in multiple conceptions of education and sustainable development (PEDROSA & LEITE, 2004). Thus, it can be considered that ESD has some characteristics that differentiate it from traditional teaching approaches and methodologies: *it is inter, trans and multidisciplinary; favors systemic and holistic analysis of reality; favors complex thinking; favors a critical view in problem solving; resorts to multiple methods and strategies of action; encourages public and democratic participation in decision-making; encourages values aimed at improving the quality of life for all beings that inhabit our planet.*

In the records of teachers about ESD, as seen in the excerpt below, which assigns teachers the role of disseminators of knowledge, characterizing science teaching as a space for reflections and analyzes on the environment and its sustainability.

> "(...) as educators, we have an essential role in the dissemination of knowledge, in the construction and reconstruction of our students' knowledge, and in this sense, the scientific training provided by science teaching must contribute to the reflection of issues linked to the environment and its sustainability." (TEACHER C)

The mediation of knowledge assumes the function of people's interaction with their environment. Thus, this will be possible if knowledge is characterized as dynamic and concrete and is attached to the human and social meanings attributed to environmental problems, thus becoming educational instruments (SAVIANI, 1994; LIBÂNEO, 1986). The ESD assumes a role that goes beyond the mere dissemination of knowledge, by proposing learning for change and transformation, considering sustainability as a guiding axis in the teaching and learning process of knowledge related to environmental issues, which may become a theme central or articulator for the understanding of such questions.

Critical thinking is one of the concerns that appears in most of the records analyzed.

> "(...) that teaching must encourage students to think critically, helping to better understand transformation processes, and that it helps in the acquisition of skills and knowledge that favor acting in favor of the environment." (TEACHER D)

Although education does not have all the answers for facing environmental problems, considering the environmental complexity, it is essential to point out ways. In this sense, it corroborates the idea that teaching must encourage critical thinking, thus favoring complex thinking, so necessary for the analysis and resolution of environmental problems.

Teachers understand that the *locus* of training for ESD is the school, as they understand the school as a learning environment on environmental issues, which contributes to environmental sustainability.

> It is at school that we can propose ecologically sustainable proposals that do not harm the environment, do not harm future development, that is, it is a way of developing without creating problems that may disturb and/or impede the development of the next generations (...) " (TEACHER A)

> "(...) I think that a 100% sustainable School is almost impossible, but we can get very close to a space for learning and growth by being very responsible with future generations, that is, respecting the environment. (...)" (TEACHER B)

It was observed that the understanding of most teachers about the concept of sustainable development is close to the definition expressed in the Brundtland Report (1987) –" *development that seeks to meet the needs of the present generation without compromising the ability of future generations to meet their own needs*." as observed in the speeches of teachers A and B.

> "I believe that in order to achieve sustainable development, it is necessary to go beyond the concern for the needs of future generations (...), making it necessary to think about sustainable development *of what and for whom*. (...) In my understanding, progress based solely on science and technology must be rethought, as well as the processes that lead to the degradation of the environment, (...)". (TEACHER E)

Teacher E highlights the need to go beyond concern for the needs of future generations, with the need to think about sustainable development - of what and for whom. This idea is close to what Sachs (2008) defends, which goes beyond the definition of

Brundtland (1987), defending the idea that, for development to be sustainable, it must be based on four principles: *be environmentally balanced; be economically viable; be socially fair and be culturally accepted.*

FINAL CONSIDERATIONS

Considering the proposed objective, we list some conclusions and inferences that we deem important, in order to encourage discussions and pedagogical proposals about the relationships between science, technology and environmental problems, as well as about ESD, in order to support new perspectives and proposals for the science teaching. Data analysis suggests that the teachers' statements about the relationship between science, technology and environmental problems, as well as about ESD, are linked to the social context we live in, where discussions about the implications of science and technology in society and in the world stand out. environment.

Thus, according to our analysis, for teachers, the treatment of environmental problems is not restricted to the transmission of knowledge about their origins and consequences, however, this knowledge supports the development of concrete actions to mitigate and prevent such problems, being the school an important space for these actions. Teachers conceive ESD from different perspectives, with definitions that sometimes come close to legal documents in a systemic, transdisciplinary and interdisciplinary perspective, sometimes assume a posture that approaches the instrumental rationality present in traditional approaches to science teaching. For teachers, ESD means instructing and teaching basic principles of science and technology, in addition to raising awareness about the need to transform society, considering sustainability an important articulating theme, especially for science teaching. Furthermore, knowledge about the environment and the natural and social interrelationships that occur in the environment can lead to changes in lifestyles and a more responsible use of technologies.

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