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Review article

The social problems and the scientific education

Los problemas sociales y la educación científica

Problemas sociais e educação científica

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ABSTRACT
The contemporary time is claiming a technological scientific formation that goes to overcome the conceptual reductionism, focus in the learning of certain system of scientific knowledge and of certain specific abilities of the science, in order to prosecute appropriately, with scientific-technological foundation, the problems that take place in its daily reality and to assume its holding in responsibly the taking of decisions at the level that correspond to them, adopting a consequent attitude with it. The present work has as objective to value the social problems that have tinged the process of scientific education in the initial preparation of the professors of Biology that allows us to promote positive attitudes toward care and protection of the biological species from the perspective science-technology- society-environment, limiting the correspondence from the same one to the current scientific-technological context, influenced by the social decisions. So as to obtain the results were used the analysis and synthesis methods and the documentary study, those that showed the existence of factors that block the good development of the scientific education in the initial formation of these professors. It is considered that from an operative intellectual vision of the scientific knowledge, descontextualized of the social problems that affect the humanity, it is not insert mode harmoniously the educational work, neither to improve the development of trials, securities and attitudes that should characterize the professional and citizen that our society needs in these times.

Keywords: biodiversity; biology; Science-Technology-Society-Environment; professors' initial formation; scientific education.

RESUMEN
La época contemporánea está reclamando una formación científico-tecnológica que se dirija a superar el reduccionismo conceptual. Ello está enfocado en el aprendizaje de determinado sistema de conocimientos científicos y de ciertas habilidades específicas de la ciencia, para que pueda enjuiciar adecuadamente, con fundamentación científico-tecnológica, los problemas que tienen lugar en su realidad cotidiana y asumir

responsablemente su participación en la toma de decisiones, al nivel que le corresponde, adoptando una actitud consecuente con ello. El objetivo de este trabajo es valorar los problemas sociales que han matizado el proceso de educación científica en la formación inicial de los profesores de Biología, que permita promover actitudes positivas hacia el cuidado y protección de las especies biológicas desde la perspectiva Ciencia-Tecnología-Sociedad-Medio Ambiente, limitando la correspondencia del mismo al actual contexto científico-tecnológico, influenciado por las decisiones sociales. Para ello se utilizaron los métodos de análisis y síntesis y el estudio documental, los que mostraron la existencia de factores que obstaculizan el buen desarrollo de la educación científica en la formación inicial de estos profesores. Desde una visión intelectual operativa del conocimiento científico, descontextualizada de los problemas sociales que afectan a la humanidad, no hay modo de insertar armónicamente la labor educativa, ni de potenciar el desarrollo de juicios, valores y actitudes que deben caracterizar al profesional y ciudadano que necesita nuestra sociedad en estos tiempos.

Palabras clave: biodiversidad; biología; Ciencia-Tecnología-Sociedad-Medio Ambiente; educación científica; formación inicial de profesores.

RESUMO
A era contemporânea pede uma formação científico-tecnológica que vise a superação do reducionismo conceitual. Este está focado em aprender um certo sistema de conhecimento científico e certas habilidades específicas da ciência, para que possa processar adequadamente, com fundamento científico-tecnológico, os problemas que ocorrem em sua realidade cotidiana e assumir responsavelmente sua participação nas tomadas de decisão. . de decisões, ao nível que lhe corresponde, adoptando uma atitude coerente com ela. O objetivo deste trabalho é avaliar os problemas sociais que moldaram o processo de educação científica na formação inicial de professores de Biologia, o que permite promover atitudes positivas em relação ao cuidado e proteção das espécies biológicas na perspectiva Ciência-Tecnologia-Sociedade. Meio Ambiente, limitando sua correspondência ao contexto científico-tecnológico atual, influenciado pelas decisões sociais. Para isso, foram utilizados os métodos de análise e síntese e o estudo documental, que evidenciaram a existência de fatores que dificultam o bom desenvolvimento da educação científica na formação inicial desses professores. A partir de uma visão intelectual operacional do conhecimento científico, descontextualizado dos problemas sociais que afetam a humanidade, não há como inserir harmonicamente o trabalho educativo, nem promover o desenvolvimento de julgamentos, valores e atitudes que devem caracterizar o profissional e cidadão que precisa da nossa sociedade nestes tempos.

Palavras-chave: biodiversidade; biologia; Ciência-Tecnologia-Sociedade-Ambiente; Educação Científica; formação inicial de professores.

INTRODUCTION

The development of science today and its repercussions draws the attention of different authors, mainly those who are in charge of the educational sphere:

> In today's world, science has reached an impetuous development, producing changes in the different spheres of society. As a result of this development, the school has to guarantee the preparation of the students achieving a comprehensive

> training, which corresponds to the new advances (Martínez, Echeverría & Hernández 2021, p. 2).

Returning to the words of Ramos (2008): "In the educational context teaching and learning science requires a certain epistemological vigilance, which prevents epistemic acts from being led by approaches that simplify and distort the real nature of scientific praxis" (p. 10). For this reason, it is necessary to present science as it emerges from contemporary debate. You don't just need to know of science, but about science.

In the current context, science has had important modifications: in the objects it studies, in its methods and forms of work, in the relationships between its different branches, in its connection with technology (Fonteira, 2008).

The contemporary era is calling for a scientific-technological training that is aimed at overcoming conceptual reductionism, focused on learning a certain system of scientific knowledge and certain specific skills of science and raising in the Teaching-Learning Process of science the study of science and technology from a social perspective (Núñez, 1999). That is to say, seen these as a process of social construction, as part of the general cultural preparation that every citizen must have, who must have an elementary, but correct, notion about the interconnection between social and scientific-technological development, so that can adequately judge with scientific-technological foundation the problems that take place in their daily reality and responsibly assume their participation in decision-making at the level that corresponds to them, adopting an attitude consistent with it.

In the conditions of our country and in accordance with the social goals that its management has proposed, science and technology constitute essential resources that should contribute to finding adequate solutions to the problems that our society faces.

The neoliberal globalization that affects the world today has also meant the generalization of multiple environmental problems. The paradigm of modernity, which assumed an inexhaustible planetary ecosystem, with blind faith in the happiness of humanity based on technological development and the subjugation of nature, is being questioned in the face of environmental deterioration, both physical and social, and the increase of the so-called global problems.

It is an imperative for humanity to promote a change in the approach to these problems, so that a renovating paradigm is generalized that is reborn to the world in its organic, dynamic and indivisible integrity, in which the human being is considered as part of nature and not as its master, promoting the creation of a collective planetary consciousness (Pichs, 2008).

In this sense, the most progressive forces in the world have been mobilized in order to achieve sustainable development because, beyond the ecological framework, the environmental problem constitutes an economic, political and social dilemma, directly related to the right of all beings' humans to a more just and productive life, in harmony with nature.

We are currently living a new era, full of great scientific discoveries and many technological advances due to the great development achieved by man, a development that has positively contributed to human life. However, the planet observes helplessly the results that man has had on himself and on nature, as this technology has caused great damage to the environment. Among the main problems that our planet presents we have: loss of biological diversity, depletion of the ozone layer, climatic changes, water pollution and soil degradation.

The threat to the planet's biological diversity has never been greater than today, due to the fact that the accelerated loss of this biological heritage leads to the holocaust. Plants and animals are much more than the color, joy and diversity prevailing in ecosystems and landscapes; they are priceless treasures of goods, energy, genes, food and services, necessary for life on Earth.

Multiple actions promote institutions such as the United Nations, the United Nations Commission for Sustainable Development, the Convention on Biological Diversity, International Congresses on Education for Sustainable Development and the Environment, warning of the danger it represents for the humanity the loss of biological diversity; therefore, it is necessary to conserve the genetic diversity of species and ecosystems and balance the benefits of Biotechnology, recognizing the important role of schools.

Schools as educational institutions have within their educational objectives the need to promote the objectives of Agenda 21, to adopt environmental perspectives and to deepen the concept and key messages of biodiversity for its care and protection, the need for targeted projects to promote a more sustainable society. Therefore, science education has to be adapted to the specific ecological, historical, cultural, economic and social context in which it is to be implemented, where decisions have to be made in a participatory way, including the multiple factors that interact.

Educational transformations and innovations carried out to promote interest in caring for and protecting biological diversity from scientific education can be appropriate at all educational levels; The Science-Technology-Society-Environment (CTSA) perspective takes on great significance in this regard. That is why one of the main challenges of the universities that train teachers is to graduate an educational professional who is capable of interpreting, from objective positions, the study of the issues of Science, Technology and Environment in a context of teaching, promoter of a future inclusion and discussion in the school and the community.

The previous considerations allowed detecting the following as a problem of a social nature: the need for the initial preparation of teachers for the area of Natural Sciences to promote scientific education from the CTSA perspective, so that this process better corresponds to the current technological Scientific context.

The objective of the work is: to assess the social problems that have nuanced the process of scientific education in the initial training of teachers for the area of Natural Sciences, which allow promoting positive attitudes towards the care and protection of biological species from the perspective CTSA, limiting its correspondence to the current scientific-technological context influenced by social decisions.

DEVELOPING

1. Science and scientific activity from a social-historical perspective

Woolgar (cited by Nuñez, 1999) considers that the institutionalization of science worldwide has gone through three major stages. The first takes place approximately between 1600 and 1800. In it, scientific activity takes place outside the universities, away from government and industry. Their fundamental social role was not to do science, nor to transmit scientific knowledge to citizens, in this way they only formed people with great economic possibilities who considered themselves natural philosophers. In it it is sustained that knowledge is based on the contemplation of

nature. It is through observation that it is possible to access the essence of nature. This conception shows as a limitation the only emphasis on observation; Greek thought despised the technique, the practical and considered the contemplative or theoretical life superior. Plato and Aristotle proposed that no manual worker could be a citizen; artisan and manual work is shameful and deforming (Núñez, 1999).

Between 1800 and 1950 the academic stage passed. It agrees with Agazzi (2010) when he states that in this stage scientific activity is developed fundamentally in universities with an essentially basic character and considering science with a pure character. An image of science that frequently finds its expression in the philosophy of science of positivist roots is consolidated. According to Núñez (1999), in this image science is conceived as the search for truth and its task is to produce certified knowledge, that is, objective and proven. An effective, rational, experimental, mathematical, mechanistic science, as far as possible from the interference of other values and interests that are extrinsic to value and cognitive interest.

Several researchers have collectively called this approach the classical conception of science, which was predominant until the 1960s. The limitation to achieve, from this conception, a socially contextualized vision of the sciences is that the fundamental methodological prescription of this classical conception of science is the separation of the intellectual sphere from the psychological, sociological, economic, political, moral and ideological factors. It ignores or underestimates the role of social factors in technological scientific development, projecting a formalistic and abstract image of science.

This conception received severe criticism in the work of different authors: in particular Kuhn (2000), who made evident the logical-positivist crisis and the need to develop a social image of science. However, since the 1940s an "opening" had already emerged in the explanation of science, since Robert K. Merton had focused his attention on its social organization.

The 20th century marks a new milestone, Max Planck and Albert Einstein burst into science with hurricane force and totally breaks with the conceptions of the past. In science, two new theories, Quantum Mechanics and the Theory of Relativity, represent a revolution that changes the role of man in the study of nature (Bernal, 2008).

Approximately in the mid-twentieth century, events related to the development of atomic theories and the use of nuclear energy for war purposes triggered positions for or against certain scientific and technological uses with the appearance of evaluative attitudes towards science and of their responsibility in the course of the events (Marco-Stiefel, 2001).

The social trend begins to break through and with it the vision of the complex and plural nature of scientific knowledge, thus entering the third stage (late 70s to the present). This trend represents a radically different option in the field of scientific training, since it allows science, rather than as a single and inexorable result, to be seen as a social process, a practice that integrates psychological, social, economic, and political and cultural factors. Always influenced by values and interests.

Starting in the 1980s, the following characteristics began to be incorporated: scientific knowledge is a social construction and scientific activity a sociocultural practice (Díaz Balart, 2001), where cultural and social elements are as important as cognitive ones. Science can be analyzed in all its dimensions with the theoretical and methodological instruments of social research. It is situated at the micro level of social action. Understand rule-guided action,

the application of these rules being situational, contextual, and cultural.

In decades prior to the 1980s, in the process of scientific training, curricular concerns focused on the appropriation of scientific knowledge, in order to familiarize students with scientific theories, concepts and processes. In the 80s, 90s and the beginning of this century, these trends are changing. Now it is insisted that aspects that guide science teaching socially be included in the curricula and try to relate it to the student himself (scientific and technological culture) (Membiela, 2001).

This makes us a wake-up call: we cannot continue to develop a process characterized by verbal transmission by the teacher, as the undisputed carrier of a set of true knowledge, previously selected as already established results of a given discipline and organized sequentially according to the formal structure of this. This approach makes the teacher the bearer of the truth and the only person responsible for the learning of the students, who should only appropriate the information received.

It agrees with what Acevedo (2001) has pointed out that it is not possible to change what teachers usually do in class (simple transmission of already elaborated knowledge) without transforming their epistemological conceptions, their views on science.

2. The conception of science that Biology teachers have and transmit

Just as multiple investigations have looked at the image that students have of science, others have looked at the teachers' conception of science. The latter have concluded that many teachers have insufficient preparation in those aspects related to the nature of science and its epistemology, as well as the philosophy and sociology of science (Blanco, 2001). It is common for teachers to focus much more on the concepts, theories and procedures of science, than on its construction and other aspects such as problems related to the Environment, which cause the loss of biological diversity, as well as the knowledge of the causes of these problems and lack of individual actions, thus transmitting an inadequate and incomplete conception of their discipline.

From this type of science education, it is difficult to ensure that citizens can:

- Develop personal criteria on basic scientific and technological issues of the time.
- Recognize and value contributions of science to improve people's quality of life.
- Use the procedures and attitudes of scientific activity in daily activities.
- Value scientific knowledge as a process of social construction in evolution and in continuous revision, which responds to the characteristics and needs of society at a certain historical moment.
- Develop a critical, active and responsible attitude to the great problems currently posed between science, technology and society.

As a result, students frequently present an inadequate conception about the validity and reliability of scientific knowledge, about how science is built and how it evolves, as well as the impact of science and technology on society (Pruna, 2008). From these incomplete ideas, students conceive science as revealing the hidden truth in natural phenomena, as a body of finished knowledge and with a rigorous and strict methodology that consists of a series of ordered and pre-established steps.

This unrealistic conception of science constitutes a serious obstacle to its learning, since it reinforces naive concepts that are

difficult to modify during the scientific education process.

Therefore, there is a need for the teacher to understand the importance and significance that it has for the scientific education of the future generation of teachers to work in classes on the role of chance in scientific discoveries, the importance of the replication of experimental work, scientific production as a result of the work of research teams, as well as the administrative and bureaucratic aspect from which scientific work is not exempt (Batista *et al.,* 2011).

To train teachers on the disciplines, their construction, their history and their current state, their benefits, their harms, to assess their social implications, aims to reach the conception of science as human construction (Addine, 2011).

A possible change of this incomplete and / or inadequate conception about science and scientific knowledge in teachers needs to originate from their initial training and, consequently, in their continuous training, from the inclusion of topics or subjects that refer to the epistemology, philosophy, history and sociology of science and the problems that it assumes as a social process.

3. The process of science education and its correspondence with the current sociocultural context

In the study programs of science subjects such as Chemistry, Biology and Geography, an openness towards the CTS educational approach is revealed, highlighting that, within the fundamental directions, socially contextualized scientific training has great potential, being a priority that is expressed in the general guidelines, in multiple definitions and determinations (Díaz, 2016).

However, such openness seems to be questioned with the organization of the compartmentalized content and the omission of situations-problems of a social nature. In preparing these documents, the authors declare that the traditional programs of the disciplines have been considered, without essentially modifying the contents. This is not consistent with the new educational intentions raised.

In science programs there are plenty of topics that allow the identification and selection of problems with social dimensions, but this is not done; Furthermore, scientific knowledge and technological skills have not been articulated with educational approaches that raise their social contextualization.

The center of the objective-content problem continues to be in the understanding of science and not in the formation of citizens capable of understanding, grasping the aspects and decoding the problems related to life and society. Consequently, the system of objectives that is formulated in each of the topics, focused on cognitive skills, is more consistent with the internalist conception of scientific training, than with the socially contextualized one (González, 2016).

Also consistent with this internalist conception of scientific training (whose essence is the initial training of future scientists), and not with a socially contextualized scientific conception, knowledge appears divided by blocks and with a high degree of specialization.

A curriculum in the XXI century can no longer be limited to being related to the importance of a subject within the sciences, but must be oriented towards the capacity of a certain content to allow students to face relevant problems. This is an important criterion for the contextualization of scientific training that

is overlooked by the current teacher training curriculum.

In other words, an analysis of the subject to be taught is required to help detect the fields in which the new scientific revolutions are taking place, worthy of considering in the face of socially contextualized scientific training without renouncing the basic pillars that sustain it.

4. Need for reflection in the scientific education process of essential aspects of the effective treatment in the classroom of the global problem: loss of biological diversity

It is now common cause for concern that human activities have reduced biological diversity on a global, national and regional scale and that this trend continues (Valdés, 2002). This is manifested in the loss of plant and animal populations, in the extinction and depletion of species and in the simplification of communities and ecosystems.

The conservation of biological diversity is essential to increase the capacity of communities to maintain their own culture. Biological diversity has a determining influence on cultural, economic, social and spiritual development and on people's quality of life (Santos *et al.,* 2016).

Numerous individuals, organizations and countries have worked in recent decades to identify populations, species and habitats threatened with extinction or degradation and to reverse these trends. The common goals are to more effectively manage the natural world to mitigate the influence of human activities, while at the same time enhancing the development options of disadvantaged peoples. Many conservationists hope that history will show that 1992 was a turning point. In June of that year, the Convention on Biological Diversity was presented for signature at the United Nations Conference on Environment and Development, held in Rio de Janeiro. The agreement entered into force at the end of 1993, and by the beginning of 1995 it had been signed by more than 100 countries; this means that they agree with its aims and that they will do everything possible to comply with its provisions (CITMA, 2014).

The general objectives of the agreement are: to conserve biological diversity, use long-term sustainable biodiversity and loyally share the advantages of the use of genetic resources (in plant selection and biotechnology, for example). The difficulties are many and impressive, but the agreement constitutes the only comprehensive global framework to plan and undertake the necessary actions (CITMA, 2014).

The loss of biological diversity as a global problem has to be dealt with in school institutions, that is, in the classroom where the new man is forged so that the child, adolescent or young person learns to take care of the Cuban flora and fauna that are of a Extraordinary wealth, due to the abundance and variety of species that it has, which is why it was once called "naturalists' paradise". It is important that the student is taught the value of each species; not only from the biological and economic points of view, but also for the role they play in ecosystems and in nature in general, due to their intra specific and inter specific relationships, the protection of soils, the climate, and so on.

Students must know how to value the country's biodiversity, not only as a national heritage, but also, due to the large number of endemic species that we possess, as a world heritage site (Lugo, Álvarez & Rodríguez 2017).

To undertake the beautiful task of conservation, our Revolutionary Government has established a National Network of Protected Areas distributed throughout the country, with the aim of comprehensively protecting our species and natural landscapes or other objects that require this measure. In

this way, these resources are preserved for the enjoyment and knowledge of current and future generations.

We agree with Armiñana (2017) when he states that the decline in biological diversity has a negative impact on the knowledge that teachers in initial training must achieve regarding this component of the Environment, since in the development of practical classes and Field practices become very difficult, and sometimes impossible, to have a diversity of species to be able to study them and then identify them in nature, to understand their role and importance in nature as a biotic factor and its impact on society.

The best way to undertake this task of protection and conservation of the different species is by teaching students in our educational institutions that they should not be damaged, since they make our social areas pleasant; Furthermore, they fulfill functions in nature, without which life would not exist on the planet.

In addition to this high endemism, many of our species are known worldwide for their beauty and rarity. Such is the case of our *Polymita,* a genus of Cuban terrestrial mollusk that is famous for the variety and beauty of its colored shells. These mollusks inhabit the eastern provinces of Cuba and have suffered excessive exploitation and destruction of their original habitat, for which they are in danger of extinction. This also causes the possible disappearance of the loggerhead hawk (*Chondrohierax wilsonii*), which feeds mainly on this terrestrial mollusk, so its population is currently reduced to a very restricted area (Armiñana, 2017).

The zunzuncito or fly bird *(Mellisuga helenae*), an endemic species distributed throughout the national territory, also deserves to be highlighted; It is a rare bird and considered the smallest in the world. Their nests are destroyed by fanatics who use their eggs in witchcraft practice; this contributes to the decline in the number of species and, therefore, the danger of disappearing one day (Cruz, Martínez, Fontenla & Mancina, 2017).

Man and society are in charge of taking individual and social actions aimed at protecting these species, among which we can mention: avoiding the destruction and / or transformation of habitats, avoiding harmful agricultural practices (use of pesticides), avoiding the overexploitation of species of economic interest, avoid hunting and fishing in the breeding season, avoid contamination of water sources, avoid the overuse and misuse of aerosols, avoid acid rains due to industrial activity, and so on.

In this sense, the creation and development of programs that enable the active participation of students in the knowledge, assessment, prevention and correction of environmental problems from educational institutions is essential. This allows us to realize the importance that it currently has and is given to citizen participation in environmental problems (Batista, 2004).

This participation can be achieved from the Teaching-Learning Process, actively sharing with the students the tasks that aim to solve environmental problems, within them the problem of the loss of biological diversity, helping to develop a sense of responsibility and become aware of the urgent need to pay attention to these problems.

One of the fundamental ways to achieve these objectives is the realization of activities inside and outside the classroom, aimed at sustainability; that is, we refer to the preservation of ecological, economic and social balances that support social well-being, economic progress, cultural enrichment and personal growth, where students are not a source for obtaining information, but where they themselves are the main researchers. It is important that they have a direct participation in this process, that they

guarantee the improvement of the quality of life, respect for all forms of life, based on personal responsibility, the sustainable use of natural resources and the preservation of the conditions that allow ecosystems to renew themselves, respect for cultural diversity and intergenerational responsibility for sustainable development (Chamizo, Socarrás & Rivalta, 2012).

CONCLUSIONS

Scientific knowledge is conceived from the different philosophical and sociological approaches, which currently reaffirm the social and partisan nature of science, which is not pure and carries ideology, forming an indissoluble part of the culture of humanity. The educational system in general and the universities that train teachers and professors in particular must graduate an educational professional who is capable of interpreting, from objective positions, the study of Science, Technology and Environment issues in a teaching context that promote their comprehensive training, so that they can be a promoter of the care of biological diversity in the context of school, community and society, taking into account that scientific knowledge is a social construction and scientific activity a sociocultural practice.

There are factors that hinder the proper development of scientific education in the initial training of teachers in the area of Natural Sciences, related to the conceptions about science and scientific activity that they manifest in their modes of action. We consider that, from an intellectual, operational vision of scientific knowledge, descontextualized from the social problems that affect humanity, there is no way to harmoniously insert the educational work, nor to promote the development of judgments, values and attitudes that should characterize the professional and citizen that our society needs in these times.

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Conflict of interests

The authors declare not to have any interest conflicts.

Authors contribution

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