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The Approach of Mendel's Laws in a Historical-Philosophical Perspective in the Rural Education Degree Course

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ABSTRACT

The article proposes the insertion of the history of science in teaching, in an interdisciplinary perspective, through a work with students of the 8th period of the degree course in rural education, qualification in Natural Sciences. In a conversation with an epistemological approach, the teachers oriented to a reflection on Mendel's Laws as a paradigm widely present in science teaching. In the course of the conversation, the linear and dogmatized way that science is often presented in its teaching was discussed. We emphasize the validity of the methodology for learning scientific concepts in a significant, critical and broad way

KEYWORDS

History of the sciences. Science education field education. Genetics.

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A Abordagem das Leis de Mendel Numa Perspectiva Histórico-Filosófica no Curso de Licenciatura em Educação do Campo

RESUMO
O artigo propõe a inserção da história da ciência no ensino, numa perspectiva interdisciplinar, através de um trabalho com educandos do 8º período do curso de licenciatura em educação do campo, habilitação em ciências naturais. Numa roda de conversa perante uma abordagem epistemológica, as professoras orientaram para uma reflexão sobre as Leis de Mendel enquanto um paradigma amplamente presente no ensino de ciências. No decorrer da conversa, foi discutida a forma linear e dogmatizada que, muitas vezes a ciência é apresentada em seu ensino. Ressalta-se a validade da metodologia para a aprendizagem de conceitos científicos de forma significativa, crítica e ampla.

PALAVRAS-CHAVE
História das ciências. Ensino de ciências educação do campo. Genética.

El Enfoque de las Leyes de Mendel en una Perspectiva Histórico-Filosófica en el Curso de Grado de Educación de Campo

RESUMEN
El artículo propone la inserción de la historia de la ciencia en la enseñanza, en una perspectiva interdisciplinaria, a través de un trabajo con estudiantes del octavo período de la licenciatura en educación rural, titulación en ciencias naturales. En una conversación con un enfoque epistemológico, los docentes se orientaron a una reflexión sobre las leyes de Mendel como paradigma ampliamente presente en la enseñanza de las ciencias. En el curso de la conversación, se discutió la forma lineal y dogmática de que la ciencia se presenta a menudo en su enseñanza. Destacamos la validez de la metodología para aprender conceptos científicos de manera significativa, crítica y amplia.

PALABRAS CLAVE
Historia de las ciencias. Educación en ciencias educación de campo. Genética.

1 Introduction

Education implies the introduction of the individual into culture by relating specific issues to each other and to the social, ethical, religious, economic and political context, overcoming the fragmentation of knowledge and leading to dialogue between knowledge. Given this, the teaching of science in the field school should explore the interaction between science and the cultural traditions in which it is incorporated. A teaching of science is advocated in the field education, in a liberal, realistic and contextualized approach, enabling a formation that privileges and commits to meaningful learning, and promotes motivation, creativity and knowledge construction.

In this sense, the history of science is one of the subjects present in the curriculum of the qualification in Natural Sciences of the Degree in Education in the Field, of the Northern University Center of Espírito Santo and has a workload of 60 hours, being offered in the 8th. course period. The course focuses on the development of science throughout history, having as its theme: the heritage of the Middle Ages; man and nature in the Renaissance; the experimentation and mathematization of science; the Newtonian synthesis and its consolidation in the eighteenth century; the revolution in chemistry: the work of Lavoisier and his contemporaries; the atomic hypothesis; machines, energy and probabilities: energy conservation; the laws of thermodynamics and the concept of entropy; probabilities and statistical mechanics; electromagnetism; the life sciences in the nineteenth century: experimental medicine; the microbial revolution; evolution and natural selection; the emergence of new physics from the late nineteenth century; atomic theory, relativity and quantum physics; contemporary science: molecular biology and genetic engineering.

The main objective of the course is to understand and problematize theories and methods that underlie the production of scientific knowledge, that is, social, cultural, political, ethical, religious, philosophical aspects that influenced and influence the theories of science throughout history. The methodology developed in the classes involves dialogued classes, collective problematization and systematization of productions about the contents; collective elaboration of educational intervention work plans; as well as videos, poetry, music, and art analysis. As evaluation of the discipline, we propose written productions and presentation of oral and written works. During the semester readings are also indicated to provide debates and seminars on the content of the discipline, and participation in these activities is also evaluated.

In the Rural Education Degree Course, the face-to-face stages are equivalent to the semesters of regular courses, and are carried out under the pedagogy of alternation, in which the education of the students takes place between time / space course and time / community space. field school. Within this perspective, it is proposed, in community time, activities that relate the contents seen in the classes of the history of science discipline, to the reality of the field, the place of origin, the application of knowledge, both in the rural school and in the rural community. Examples of works carried out in community time within the history of science discipline: interviews with the rural population about traditional knowledge and the history of local development; the changes, impacts, benefits and losses in rural areas caused by the evolution of science; science and ethics; science and power; information that is brought from the community, valued and expanded at university time, through scientific knowledge.

To give meaning and effectiveness in field education, the history of science discipline must connect science not only with its history but with topics of philosophy, literature, psychology, technology, economics, as well as interconnections with culture, the arts, ethics, religion and politics. From the history of science thus constructed, we provide students with the understanding that there is no temporal linearity, nor a continuous evolution and progress in the construction of scientific knowledge, but that scientific elaborations are discontinuous and influenced by the factors previously mentioned. Moreover, in our understanding, the meaning given to the history of science must be broad and meaningful in the life of the peasant and his social struggles.

Thus, aiming to reframe the conceptions about the nature of science of field students, the work presented involved a dynamic for the development of genetics concepts in a philosophical historical perspective, from an interdisciplinary approach that integrated history, science, political aspects, religious, social, ethical, demonstrating the complexity of the real world. The activity was developed with the students and students of the 8th period of the degree course in field education, qualification in natural sciences, within the discipline of history of science.

2 The Degree Course in Rural Education

The degree courses in rural education were born out of the longing of the rural people, who fought (and still fight) for an education linked to the struggle for land and the maintenance of peasants in it. These courses value an education that values the knowledge of the people of the countryside, based on Paulo Freire's liberating pedagogy and aims to train educators to work in the final years of elementary and high school, in processes of basic schooling. youth and adults from peasant communities, in educational sectors of social movements and in other educational and / or political-pedagogical processes (FERNANDES, 2008).

The degree course in rural education, organized by the Department of Education and Human Sciences (DECH), is offered by the Federal University of Espírito Santo (UFES) and is linked to the Northern University Center of Espírito Santo (CEUNES), which, for its Instead, it follows the administrative orders defined by the higher deliberative bodies of the University[1]. The course was created at the initiative of teachers from DECH, from the native school and from the professionals of the department of education of São Mateus.

[1] UFES. Pedagogical project of the degree course in rural education. CEUNES: Saint Matthew, 2012.

The proposal of the degree course in education of the field CEUNES / UFES stimulates the partnership with educational entities that act in the formation of educators and with the populations of the field. In addition, the course meets the demands of the northern region of Espírito Santo, southernmost Bahia, and eastern Minas Gerais. For this reason, the Northern University Center of Espírito Santo seeks to strengthen partnerships and participation of municipal education departments and rural social organizations: rural workers 'movement-MST, small farmers' movement - MPA, regional family associations forming. in alternation of Espírito Santo - RACEFFAES, *Quilombola* and indigenous communities, fishing colony.

A degree in field education at CEUNES offers students the choice of two areas: nature sciences or humanities and social sciences. Each student can choose to qualify in one of them, which will be certified. The curricular organization foresees in-person stages (equivalent to semesters of regular courses) alternating between time / space school-university and time / space community-school field. The course prioritizes the intrinsic articulation between education and the specific reality of rural populations. In addition, conditions for access and permanence in the course of acting teachers are provided, that is, to prevent the entry of youth and adults into higher education reinforcing the alternative of leaving the countryside.

In this context, according to the pedagogical project of the degree course in rural education (2019), the following are considered rural populations: family farmers, extractivists, artisanal fishermen, riverine settlers and settlers of agrarian reform, rural salaried workers, quilombolas, "*caiçaras*", forest peoples, caboclos and others who produce their material conditions of existence from work in rural areas. The rural school, on the other hand, is the rural school, as defined by the Brazilian Institute of Geography and Statistics Foundation (IBGE), or the urban school, provided that it predominantly serves the rural populations.

It is noticed that the student of the rural school has a very rich worldview, where culture, mysticism, class struggle, popular knowledge and traditions must be valued and expanded by scientific knowledge, in a knowledge constructed and contextualized by reality, with its problems and challenges, within historical, social and political aspects, giving meaning to knowledge.

The graduate in rural education, being aware of this diversity of knowledge, must act respecting the existing regional context, in the historical, social, cultural and environmental aspects, in an action that interacts with the interests and does not devalue or inhibit the history of knowledge. existing on site.

3 The Approach of Mendel's Laws from a Historical-Philosophical Perspective

The history of science in teaching can contribute to more challenging classrooms and improve critical thinking and thinking skills, a fuller understanding of the scientific subject. It can help to overcome the "sea of meaninglessness" (MATTHEWS, 1991), where formulas and equations are "recited" without knowing what they mean or refer to. Another contribution of the historical approach to science lies in the epistemological formation of teachers, helping them to develop a more authentic understanding of the nature of science, as it interferes with the way they approach content, how they teach it and the message they convey to students. Without this knowledge, teachers risk presenting truncated versions of curricula, a view of science as absolute truth, and historical facts only as examples or illustrations of scientific content without analysis or criticism (CARNEIRO; GASTAL 2005). As educators, they need to understand how and under what circumstances scientific knowledge emerged and developed, its implications for society, and its limitations.

Science has a history that can demonstrate the relationship between science and the world, involving past and contemporary problems. The history of science is often overlooked in teacher education courses and also in the contents of textbooks, but when present it is often illustrative and not explored by teachers. According to Porto (2010), it is necessary to bring the future teacher closer to the debates about the history of science, giving a first-hand experience of the complexity of the construction of scientific knowledge.

Matthews (1995) argues that there is a relevant concern with the science teaching scenario, in which a significant lack of reflection on its nature has been diagnosed. It also argues that the insertion of the history of science in teaching denotes a relevant didactic potential, thus enabling learning with a more systematic and relevant understanding of the nature of science. Thus, the teacher should address how science has developed in conjunction with other areas, in mutual interdependence within a culture, a society. It is understood that the history of science can humanize the vision of science, revealing it as a process and not a finished product, promoting a better understanding of the construction of scientific knowledge over time, as well as its dynamics.

In addition, the adoption of science teaching from a historical-philosophical perspective as a pedagogical practice in the classroom allows a systemic approach to content relating science-technology-society and environment, contributing to the effective scientific literacy of the student, empowering him as a critical and active citizen in your reality.

It is also important to highlight that the current historiography of science should bring epistemological reflection that allows the understanding of the complex relationship between science, technology and society (MARTINS, 2006). There is the criticism of the conceptions defended in the old historiography that presented a neutral and cumulative view of science (socially neutral), as well as the tendency to present the history of science in teaching in a decontextualized way and based on the transmission of content.

Teaching from the history of science promotes an approach context with the nature of scientific knowledge, allowing teachers explore the cultural, social, economic, political and philosophical aspects present in the period of knowledge building. This way, it is possible deconstruct the neutral and cumulative view of science, genius, discovery and impartiality of scientists, perceiving science as a historical and human construct, an open knowledge that can at any time be refuted, altered, not being an absolute, ready, static truth. Given this, caution is needed in the selection, and a critical analysis by the teacher, of the teaching materials used.

Within this context, several studies show that the concepts of genetics are difficult to develop in class, being presented in distorted ways to students at different levels of education, including university education (LIMA et al., 2007; PAIVA; MARTINS, 2004, apud SILVA, 2014), and also in teaching materials (VILAS-BOAS, 2006), such as books. Many books used in schools end up reinforcing, according to Vidal and Porto (2008), a pseudo-history of science, not contributing to the formation of a critical view on the process of construction of scientific knowledge, so important for the initial formation of teachers, in particular the training of the graduate in field education.

According to Silva (2014), the teaching of genetics has been pointed as a necessity in the formation of conscious young people capable of making decisions regarding their own life, also contributing to the understanding of individual differences, in an emancipating and liberating education. Nevertheless, Neto et al. (2015) state that genetics is one of the most challenging subjects of teaching, not only due to the complexity of its contents, which require great capacity for abstraction or its rapid advances in recent decades, but also due to the lack of historical contextualization.

One of the difficulties in teaching genetics is related to the poorly integrated and fragmented approach to content, often present in curricula and textbooks, as can be observed in the approach given to Mendel's laws. It is common for this content to be presented in a watertight, deterministic, conclusive and logical perspective, disregarding the whole study process performed by the researcher at the time, his competence as a student, the errors and deviations of thought during the study of peas, and the need to denominate “laws” a knowledge that does not operate as such, being permeated by exceptions to the rule. To reduce these gaps, this paper presents a class held within the discipline of the history of science, with the objective of debating and reframing the teaching of genetics, in order to foster the adoption of the historical-philosophical approach by future educators, reflecting on the possible implications of this approach for teaching.

As future teachers in the field of natural sciences, it is necessary to understand the genetic theme and heredity that should be developed in basic education, specifically, from the ninth grade of elementary school (BNCC, 2017). In high school this subject is deepened by studying Mendel's laws in specific. According to what is stated in the Common National Curriculum Base for high school (2017, p. 542), such knowledge is fundamental to “… make arguments, make predictions about the functioning and evolution of living beings and the universe, and ground ethical and ethical decisions. responsible”. In this sense, considering the need for citizenship foreseen for Basic Education, the teaching of genetics in the historical-philosophical perspective expands the opportunities of critical formation of the subjects and, thus, the discussion of desirable and undesirable aspects becomes important, for teaching

Gregor Mendel (1822-1884), (Figure 1), still considered by many to be the "father of genetics", was a naturalist, a student of areas such as physics, mathematics and natural history (BRANDÃO, FERREIRA, 2009). He developed his research with the Pisum sativum pea and other plants over approximately eight years. His studies were based on a well-known hybridization protocol at the time, which he used to promote crosses between plants. The great innovation in which their experiments were the possibility of predicting the proportion of the different characteristics present in future generations of pea plants.

Figure 1. Image of Gregor Mendel.

Source: livescience.com

The possibility of investigating peas in a monastery, their ancestry in a family of farmers, the knowledge gained in statistical studies, the already widespread and stabilized hybrid breeding technique, and other social aspects of Mendel's life have considerably interfered with development. of their experiments, although their results were not recognized as soon as published. The established knowledge about heredity at the time differed from what the Mendelian experiments pointed out, being an obstacle to the acceptance of the results of Mendel's experiments, as well as its implications for science (BRANDÃO; FERREIRA, 2009).

These aspects, now neglected in the vast majority of textbooks, lead students to conceive of the mistaken and delusional idea of genius, or to understand the production of knowledge as a sequence of fortuitous events (CARNEIRO; GASTAL 2005), among other conceptions that cover up intentionality, the interference of the social, political, economic and cultural context in the construction of scientific knowledge.

Prior to Mendel's Laws, paradigms such as preforming theory, epigenesis, and pangenesis predominated. It was not until 1900 - with the resumption of Mendel's ideas by Hugo de Vries, Carl Correns and Erich Tschermak - that genetics was “rediscovered” (COUTINHO, 1998, apud NETO et al., 2015). Although belatedly spread, Gregor Mendel's ideas provided a “scientific revolution” by establishing itself as a paradigm. However, it is noticed in textbooks and biology teaching, often a superficiality and lack of criticality in the approach of the subject, highlighting a genius in Mendel's work. But were such ideas formulated by Mendel's enlightened genius or his thorough work?

4 The Methodological Path: The Wheel of Conversation

According to Sampaio et al. (2014), as a working methodology, the wheels of conversation constitute a “liberating political strategy that favors the human, political and social emancipation of historically excluded collectives” (SAMPAIO et al., 2014, p.1300). This proposal demarcates the critical pedagogy of educator Paulo Freire (1921-1997), whose main objective is to contribute to the epistemological foundation for a contextualized educational act, in which the ideas of education, freedom and transformation of individuals and the environment in which they join. These live.

The wheels of conversation are spaces for reflection, criticality and dialogue, foundations of a problematizing and liberating education. Thus,

> The space of the conversation circle intends to construct new possibilities that open to thinking, in a continuous movement of perceiving - reflecting - acting - modifying, in which participants can recognize themselves as drivers of their action and their own possibility of “being more". The fact that dialogue is seen as open and egalitarian does not mean that these negotiations are peaceful, since in these spaces power games and questions are put to hegemony (SAMPAIO et al., 2014, p.1301).

In this dynamic, according to Melo et al. (2016), the exchange of knowledge produces spaces for reflection, starting from the recognition of the differences of each participant. The “pedagogical arrangement of the wheel” (MELO et al., 2016, p. 301) also leads to the problematization of reality for the subsequent awareness and construction of meaningful learning.

The conversation wheel was used as a didactic modality during a class in the history of science discipline, in the field education degree course, in an eighth period class, in the third stage of university time. This class aimed to re-signify the conceptions about the nature of science, in relation to Mendel's laws, in a historical-philosophical and interdisciplinary approach. To this end, participated in this class, in addition to the class and the teacher of the discipline of history of science, the teacher of the discipline of biology.

In preparation, there was a prior dialogue between the teacher of the history of science discipline and the biology teacher. This initial conversation was fundamental for the educators to elaborate a relevant activity for the field education, that connected common points between their subjects and other curricular components, allowing to elaborate a coherent, interdisciplinary and collective proposal.

The students were prepared by reading an article about Mendel's studies and later discussing the content, raising questions of interest. These questions dealt with Mendel's genius, his ease with which to study, the patterns and logic of his discoveries, their implications for modern science, and the linearity of science, that is, the progressive and deterministic path that science would take. Some questions that arose during the previous debate were: did the "geniuses" of science work alone for the sake of science, of humanity? Were your discoveries the result of careful, detailed work within a paradigm with certain interests? What were the interests in Mendel's research? How did Mendel come to these results? What ideas did Mendel have when conducting experiments? What was it based on? After all, was Mendel simply a genius? Did Mendel already know what not to do? What / who was it based on? Are there proto-theories in their experiments?

To help answer these previous questions and discuss the subject with the students, in the second moment of the class there was the participation of the biology teacher during the conversation. From an epistemological perspective, the biology teacher guided the class in a reflection on Mendel's laws as a paradigm widely present in science teaching, on the context of his studies and on the justification of scientific research. In the course of the conversation, which lasted 60 minutes, the linear and dogmatized way that science is often presented in its teaching was discussed, where scientific activity would be elaborated by geniuses, with countless moments of "Eureka".

Another aspect explored during the conversation was that before Mendel elaborated his postulates, many others had already been developed. Mendel made no assumptions or predictions by mere observations. The choice of peas as an object of study did not come by chance. There was prior knowledge that provided Mendel with a legacy of information that allowed him to organize existing knowledge by choosing simple and efficient methodologies that could meet his expectations, test hypotheses and provide data.

Mendel's research was not big news at the time, and he adopted experimental procedures common to the hybridizers of the region in which he lived: Moravia. The difference was how you looked at your results, focusing on analyzing one feature at a time, not as many as others did. In addition, he directed great attention to the proportions obtained in the crossings of pea species, mathematizing their results. Mendel made his choices based on consolidated knowledge, using the pea (Psium sativum) in his studies and chose to analyze discontinuous variables (such as the pea shape, which may be smooth or rough, or its color, yellow or green), rather than features with varying gradients (such as plant height), which would hardly give accurate results in terms of offspring proportions.

However, Mendel's vision as an isolated monk in a monastery, growing peas in a small flower bed where he "lightly" discovered genetic inheritance patterns is common in classes and textbooks. His ideas were influenced by his background, the environment in which he lived, and the socioeconomic and historical-cultural aspects of the time. In other words, Mendel belonged to various groups or styles of thinking, which can be defined as communities of individuals who share academic, scientific, cultural, and social practices, conceptions, traditions, and norms. The style of thinking determines the way of thinking of a collective at a given historical moment (LEITE; FERRARI; DELIZOICOV, 2001, p. 98). Among them we can mention the traditional Moravian group of hybridizers, which aimed to select favorable characteristics of a species to meet economic and agricultural objectives. In addition to the hybridizer group, Mendel was influenced by several other thinking styles: from religious (Figure 2), scientists, biologists, farmers, physicists, meteorologists, even collaborating to establish a new collective, the collective of geneticists that derived from it.

Figure 2. Monastery in the early 1860s: Mendel contemplating a flower.

Source: revistapesquisa.fapesp.br

Mendel justified his research under a complex process of observations, interventions, theorizing, data collection, model making, peer-to-peer dialogues of various thought collectives, etc., along long and diverse paths. However, at the time, Mendel failed to break with the prevailing paradigm, as is the case of the heredity by mixture thesis, which stated that, in fertilization, paternal and maternal information are mixed in hybrids. That is why his theories were rescued only in the twentieth century. Even belatedly recognized, Mendel's theories were able to explain that the traits obtained in subsequent generations did not originate in intermediate mixtures in the offspring, also demonstrating the discrete behavior of the traits of organisms over the generations.

5 Results and Discussions

During discussions in the conversation between students, students and teachers, it was possible to debate visions related to the collective character of science, the influence of scientists' conceptions, their beliefs and interests in the interpretation of a phenomenon or in the elaboration of a theory, constantly influenced. by the social and historical environment in which they are built, the human character of science, with errors and successes. After the class was held, the students were unanimous in stating that the development of scientific knowledge encompasses influences of the socio-cultural / political-economic context of the time the researcher lived, inferring that during the class, the study of the elaboration of Mendel's laws historically from his process of change (VYGOTSKY, 1984).

More than inserting such themes in the classroom, it is necessary to bring proposals that connect current or classic knowledge with the reality of the field student, which leads them to reflect on the perspective of critical teaching and the socio-historical proportion that permeates strongly, not only Mendel's laws, but also other science contents. This leads to an epistemological position regarding the contents of textbooks that often do not match the scientific context. After all, Mendel was not an enlightened hero, a reclusive researcher who, experimenting with a small flower bed, established the laws of heredity alone. In teaching, science is often presented in a linear and dogmatized manner, and scientific activity is posited as something elaborated by geniuses.

During the talk talk, teachers deconstructed, through the story of Gregor Mendel, the false idea that science is something given, finished, natural, and not a construction. The students reinforced this deconstruction in several speeches at the end of the activity. In this sense, we recognize the importance of the historical approach to science content, which ensures that content is not discussed outside the context of its history (SCHEID et al., 2005). We therefore believe that, to ensure the possibility of positioning on socially relevant issues currently debated in various social spheres, it is important to allow students to reflect on scientific-technical innovations.

6 Final Considerations

Before concluding, it is necessary to emphasize the aspect of interaction between teachers, the dialogue of knowledge, the collective construction of knowledge, the basis for interdisciplinarity. Science teachers in rural schools should lead students to contextualize, opine, discuss, intervene on socially relevant topics today. We emphasize the importance and validity of the methodology presented for the learning of scientific concepts in a significant, critical and broad way.

In addition to an interdisciplinary work, the aim of the class, in relation to getting students and students to reflect epistemologically on Mendel's laws, was achieved, given the students' statements during the course. They understood, in developing the class, the importance of the historical perspective of science as a social process, that is, as the work of men and women who, like the peasant and the peasant, are of crucial importance in the development of our country.

In the course of the activity, the conversation wheel led to the students' understanding that the context in which the “discoveries”, theories are developed, depends on several factors, including economic, political, religious, not existing. Accidental “discovery”, nor scientists who work unselfishly.

The history of science, when used in the teaching of both Mendel's Laws and any area of the natural sciences, leads the student to realize that science is a socio-cultural and historical construction, having need and importance in the initial and continuing formation. of educators.

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