WORLDVIEWS TO THE CONCEPT OF EVOLUTION AMONG STUDENTS IN AN INITIAL TEACHER TRAINING COURSE

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Abstract: The present work shows the close relation between evolution rejection and protestant fundamentalism in students from a teacher training course in Brazil, together with a discussion on the best approaches to deal with this situation. The imposition of science explanations was rejected together with those from relativistic interpretations of science.

Keywords: Biology Teaching; Science Teaching; Evolution; Creationism; Teacher Training.

BACKGROUND, FRAMEWORK AND PURPOSE

The debate opposing Science and Religion, although still held by some authors, has proved for many others to be misplaced and religious thoughts apparently still have an important place to take in the lives of many of the contemporary human beings, many times side by side with the acceptance of the most recent scientific developments and concepts. However, this does not mean, as proposed by Gould (1999), that Religion and Science peacefully took separate places in the minds of everyone as Non- Overlapping Magisteria.

Quite the contrary, the last century has witnessed the emergence of a typical modern phenomenon, named religious fundamentalism, which in the western countries had its major source in the United States of America in some conservative protestant denominations (Numbers, 2006). More directly related to Biology and Science teaching is the "scientific" facet of this movement, that albeit its religious motivations, presented itself initially as "scientific creationism" and lately was renamed by its followers as "intelligent design" (Alters & Nelson, 2002). This movement deeply opposes many of the basic ideas that form the core of the modern evolutionary synthesis and although initially restricted mainly to the United States (Scott, 2006), began to spread to other western countries especially through the activity of religious institutions.

As stated by Numbers (2006), nowhere in South America antievolutionists have made deeper developments than in Brazil, where this issue has been assuming an escalating importance and has reached its climax on March 2002, when the governor of the State of Rio de Janeiro, a Presbyterian politician supported to a great extent by the evangelicals, sanctioned the law that authorized the teaching of a new subject, "Religion", in the public schools of the State. At the time the governor took the chance to declare her support for the biblical creationism and rebuffed the idea of biological evolution of the species.

The study herein reported was carried out in an initial teacher training program in Biological Sciences in the Universidade do Estado do Rio de Janeiro (UERJ) and is located in a municipality in the outskirts of the metropolitan region of Rio de Janeiro, Brazil.

This work aims to investigate the possible association between the religious affiliations of forthcoming Biology and Science teachers and their reactions to biological

concepts related to biological evolution and its consequences. The research questions of this paper are: 1 - Is there any association between religious affiliation and rejection or resistance to the concepts related to biological evolution?; 2 - If such association is found, could it be more intense in some religions than in others? Which ones?; 3 - Which best strategies could be employed by forthcoming teachers of Biology and Science when dealing with this sort of conflicts? Which ones should not be encouraged?

METHODOLOGY

A survey of eleven questions/statements (eight dealing directly with biological concepts) was applied to all the students which agreed to participate in this study and that were following different periods in the teacher training program in Biological Sciences at the UERJ in the beginning of 2004. A total amount of 245 surveys were collected. Recorded interviews with five students from different religious affiliations were also included to complete the empirical basis of the research.

RESULTS

In almost all the biological questions of the survey, the highest percentages of disagreement between the evolutionary concepts and the worldview of the students came from those from a strong protestant background. In the first question, for instance, while 91.7% of Catholics agreed with the idea of kinship between different living beings, followed by 87.5% Non Religious students, and 84.2% of Spiritualists, only 76.5% of the Protestants did so. Besides that, among those that responded affirmatively to this question 50.91% of Catholics employed evolutionary arguments, followed by 45.83% non-religious students, and 42.11% of Spiritualists (second question). The lowest numbers (33.33%) came from the Protestants in which the typological arguments reached their highest level. The lowest percentages were also found among Protestants about the following statements: all living beings descend from a single form of life (third question, 18.4%); the human species came from another different species (fourth question, 38.5%); all species change throughout time (fifth question, 45.1%). Moreover, this was the only religious group to predominantly reject both third and fourth questions. Their answers were also quite unique since 35.29% chose the option "there is no proof that living beings change originating different ones throughout time" in the fifth question. On the other hand, their responses reached the highest levels in the following statements/questions: our species is the only rational one. Is there is a reason for that? (ninth question, 50.0% found a religious reason); what is the definition of evolution? (tenth question, 34.62% considered it only a hypothesis); have other species appeared after the origin of humans? (eleventh question, 46.15% answered negatively).

The only exception regarding the uniqueness of protestant responses to biological statements came from the eighth question, which inquired "what does it mean for a living being to be more evolved than other one?". In all religious groups the most common answer was "more adapted/specialized", revealing both a static view of the environment and a unidirectional conception of the evolutionary process, which misunderstands evolution as a process of species improvement (Protestants – 55.77%; Catholics – 46.55%; Spiritualists – 52.63%, and Non-Religious – 50.00%). In the second place, regardless of religious groups, came the answer that best expresses the evolutionary paradigm, in which the most evolved species are those "that suffered more changes throughout time" (Catholics – 34.38%; Protestants - 23.08%; Non-religious – 22.73%, and Spiritualists - 15.79%).

DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

The results herein presented reveal a significant amount of rejection and resistance among a large group of students, not to a secondary peripheral area of Biology but to the

central tenets that established this knowledge as science in its contemporary form in the first half of the 20th century (SMOCOVITIS, 1992). This rejection is by no means the result of cognitive difficulties or related to the shock of getting acquainted with a different and strange language held by the scientific community, since many of the students seem to master properly the major biological concepts they were taught and do well in most of the exams. Similar results have also been found in Brazil for future Biology teaching students by Sepúlveda & El-Hani (2010), for graduating students from different areas by Souza *et al.* (2009), for Secondary Education teachers (Tidon & Levontin, 2004), and for the pupils from elementary school by Fonseca (2008), showing that this is by no means an isolated situation and that forthcoming Biology and Science teachers should be aware of it.

The results of this work remark the importance of developing teaching strategies adequate to deal with this situation, one which surely takes into account the importance of "contextual constructivism", a term coined by Cobern (1994), which according to him would be a cultural constructivist approach. This view regards the learning process as a much more complex task than only a personal activity, always taking place in a social context.

In this way, we agree with McKeachie *et al.* (2002) that teaching strategies should involve not only the transmission of correct and up to date scientific knowledge but also need to create cognitive dissonance with some of the creationist thoughts so dogmatically held by some of these students. This dissonance should not be presented as an antagonist relation but fairly presented as worldview conflicts about certain issues to the students, remarking about the different fields in which they were supposed to act. Therefore, our main goal should be, as addressed by Pigliucci (2007), to move these students out of their comfort zones, opening their ideas to situations in which they are subjected to scrutiny and debate with other views. In this way, we should aim to foster situations that enhance the chance of argumentation by these students and that allow their interaction with new and unusual situations to take place. In this learning process the issues covered during the course are not important in themselves but the way they are used is central for the success of this methodology. However, this said, it is clear that some of them are more likely than others to promote heuristic dissonances. Various authors have suggested more promising subjects in Biology to deal with the teaching of evolution, and all of them have been proven useful in our classrooms.

Gregg *et al.* (2003), for instance, stressed out arguments based on the molecular level, such as the common structure of DNA, of the processes of protein synthesis, the presence of metabolic pathways identical in all living beings and the universality of the genetic code, among others, with the appeal not only from the logical arguments but also from the symbolic power carried nowadays by everything related to the structures and processes at the molecular level. Antolin & Herbers (2001) presented evidences of evolution through situations related to current issues from Medicine (development of microorganism strains resistant to antibiotics), Agriculture (selective breeding and the generation of different varieties of animals and plants), and Biotechnology (genetically modified organisms). Images of transitional fossils - especially those that do not clearly fit into those basic kinds or types found in present animals - , together with similar embryonic developmental stages in complete different adult animals, have also posed challenging questions to these students.

Also, as mentioned by Pigliucci (2007), it is important to follow the trajectory of those students that initially had a hostile attitude towards evolutionary concepts and later have managed to overcome these conflicts. The careful examination of their mediating strategies may provide important clues about what might work or not, always bearing in mind that although individuals have different stories, some general patterns and tendencies might emerge. Accordingly, when teaching evolution later, one of our former creationist students chose to deal with the most problematic issues later, not as a way to hide them, but in order to

provide their pupils first with the basic knowledge necessary to better understand the process. Without this, their ability to fully comprehend all the arguments and inconsistencies present in the discussion would be seriously compromised and rejection would follow immediately.

This approach should be accomplished assuring the students that this is by no means a debate about Science *versus* Religion and so they must not be discouraged about their religious beliefs, therefore avoiding some aspects of science teaching criticized by Aikenhead (2002). This author has emphasized that in many instances science teaching acts as a dominating enterprise in which all students are exposed to a single culture disguised as neutral knowledge transmission. Otherwise, the same dogmatic attitude is strongly supported by most creationists in the opposite direction, and so should be answered likewise, that is, confronted with the power of debate and exploring the heuristic value of conflicts. These students come to the university bearing, at different degrees, a number of several dogmatic truths, most of them linked to the religious matrix they follow. Any other way of thinking presented to them that also work based on absolute certainties will surely be in disadvantage with their religious views. Therefore, the teaching of any dogmatic version of science, besides incurring in serious epistemological misinterpretations of the scientific activity, is also a weak and innocuous didactic strategy when dealing with these students.

We strongly believe that the best strategy is to present science as a field of questioning and discovery that almost always is tentative. This is a way of thinking that most of these students are unaware and that do not struggle for space directly with their religious views. For many of them, change and instability have necessarily a negative connotation and hence we should emphasize the importance of explanations that are not based on stability, but that rather work through critical revision, involving advances and retreats, disputes, loss of data and its recovery, besides having a generous space for stochastic phenomena. The teaching of this relentless movement is able to foster in these students the conditions necessary to better welcome some of the scientific explanations or at least debate them with consistent arguments, going beyond immediate rejection. Thus, the presence in our curriculum of a discipline about History and Philosophy of Science has helped us in teaching the nature of science, their limits and possibilities, allowing these students to recognize which explanations are parts of the scientific endeavor and which are not. The importance of the different contexts in which these explanations are applicable reveals its importance and religious explanations like creationism and intelligent design do not belong to the scientific field.

Finally, in a nutshell, our defense of a cultural constructivist approach of teaching science and its changeable nature should not be confused with some relativistic interpretations of the reality. Some of them consider any explanation of reality held by any group of people as valid as any other (including the scientific ones) based on the impossibility of seeing the real world as it is. This approach, very popular in some trendy academic circles, have been craftily framed by religious fundamentalists throughout the world in order to promote their agendas, creationism included (NANDA, 2003). Our viewpoint is based on the critical realism defended by authors like Chalmers (1993) and on our understanding that the debate between different cultures is not based on their essentialistic nature, rather considering them to be engaged under processes of multiple influence. Therefore, since knowledge is socially constructed, the best way to respect the members of a particular culture should be neither impose another foreign view over them nor isolate them from any debate and exchange with other experiences and points of view. This is especially true if the members of this group have cultural views that are based on dogmatic religious visions and are not living remotely isolated but in the outskirts of modern cities with an involuntary limited access to different sources of information.

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