

Biological Evolution in Curricula of Countries with Different links between State and Religion

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Introduction

This paper analyses the impact of the State secularization on the teaching of biological evolution in secondary school in three Latin American countries, Argentina, Brazil and Uruguay. They were chosen due to their noticeably different relations between State and Religion. School curricula of these three countries were analysed, and differences and similarities are discussed based on the possible influence of the relation between State and Religion on the design and implementation of secondary school biology curricula, with special emphasis to biological evolution.

Various factors may interfere on the decision to emphasize the contents to be taught in class (Shim, 2013), being the teacher's religion one of the important factors (Gay, 2010). However other extrinsic issues, such as the underlying public education policy, may also influence the definition of the school curriculum. According to Bourdieu (1998), it is necessary to consider the political discourse and the historical construction of the curriculum content. In



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other words, the forces that influence teachers in multicultural education practices must also be investigated.

Journell (2013) has proposed that the study of the controversy on teaching biological evolution and the challenges that it causes to teachers may provide a basis for a better understanding of phenomena that take place in the classroom. Biological evolution has been neglected in secondary education by intrinsic and extrinsic reasons to biology teachers, one of which is supposedly the school curriculum (Rutledge and Mitchell, 2002). Trani (2004) attributes teachers' rejection or denial of biological evolution partially to their own lack of knowledge of the evolutionary theory and of the nature of science. This view is also supported by Blancke *et al.* (2011), who have observed more and more students in the classroom advocating creationism, which places teachers in conflict situations.

Also the Council of Europe (2007) has strengthened the increasing danger of creationism in education, especially in scientific education. This European international organisation further points out the risks of this movement impact on science curricula, which must be vehemently avoided, and that the creationism issue must be limited to religion classes. In contrast, Nord and Haynes' (1998) suggest the introduction of religion in all areas of education (including the formal curriculum and, particularly, in science education) as a teaching moral guideline.

In a conciliatory position, Mayer and El-Hani (2013) consider that creationism must not be ignored, but rather appraised when students raise the issue, especially regarding its impact on students' education and the degree of its influence on education and science policies. Nevertheless, these authors do not argue for the introduction of creationism by the science teacher. Finally, it must be taken into account that the curriculum construction and design is associated to the construction of the historical educational policy of the country, with its particular emphasis and denials that are specific to each culture (Maia and Pereira, 2011).

Why a comparative study?

The report on “Comparative Analytic-Descriptive Study” of the MERCOSUR Educational Sector (INEPEAT, 2005) deals with the relevant role of analysis in a comparative approach to integration and decision making in the educational sector. It points out that comparative studies help in the understanding of the origin of the problems and in the proposition of possible solutions. Thus, such comparative studies can give evidence of current situations as well as point out problems and achievements.

Comparison is a natural human trait, but the history and culture of each country must be taken into account in scientific investigation (Franco, 2000). A study may start its methodological reflection by looking at similarities, however, the present study guides its analysis by the differences, which requires formulating questions considering the way the differences were constructed. Comparisons may be relevant when what is taken as natural by someone is questioned by others, especially when the latter live in a different reality, in another country, under a different State-Religion relationship. This study approach is expected to elicit new questions about the countries, either comparative or not, and possibly leading to further researches. Goergen (1991) points out the need for comparative studies, which are lacking in the education area, as compared to economics, sociology and other fields that develop numerous comparative studies. In a large comparative study involving 19 countries, Carvalho and Clément (2007) have found clear differences in teachers' conceptions, in curricula and in textbooks, especially regarding controversial questions (e.g. sex education, health education, environmental education and evolution) that are matter of social and scientific debates.



Having in mind that the present study intends to analyse whether State-Religion relation influences the curriculum design and its contents, the so-called "hidden curriculum" of the analysed countries also needs to be considered. Hidden curriculum is understood as the implicit taught contents, which is not included in the formal or written curriculum where teachers base their teaching (Jackson, 1998). Secondary school and teacher training course curricula often have gaps in biological evolution contents, and even when they do not have such gaps, the teachers' conceptions and representations are influenced by their personal beliefs that tend to influence significantly what is taught about in the classroom. Major differences may exist among secondary education biology teachers regarding the three important aspects of the teaching of biological evolution: what, how and to whom to teach it (Diaz, Ercoli and Ginestra, 2009).

Finally, it is important to take into account how the curriculum of each country is designed, within its own historical and political condition, and how political groups are associated with Religion.

Curricula as comparison instruments

The curriculum is one of the references to set up comparisons of biological evolution teaching in different countries. Multiculturalism is an inevitable condition in the present world that cannot be ignored and may be perceived in various ways revealing how individuals, groups and institutions respond to cultural reality and power relations (Moreira, 2002). Education, curriculum policy and citizen education are associated with theoretical discussions and debate in this field (Maia and Pereira, 2011). Therefore, it is relevant to investigate how the biological evolution controversy runs through the countries curricula, as it can affect scientific education of secondary school students.

Multiculturalism has been considered in curriculum research, since cultural differences must be taken into account in curriculum analysis (Moreira, 2002). It is important to theorize on the different conceptions and investigate how these conceptions affect curricula. Moreira (2002) also considers that differences in curriculum design are political issues and that the underlying mechanisms and institutions must be discussed as well. Indeed, the so-called "external didactic transposition" proposed by Chevallard (1985; 1992) analyses the reason why some contents, and not others, are selected to be taught; such selected contents are defined by policy makers and constitute the curricula and school programmes from which the school textbooks are based on (Carvalho & Clément, 2007; Carvalho, 2009). This is to say that values and ideologies determine what knowledge is valid and important for educational purposes and so to be considered in curriculum (Leite, 2000; Carvalho & Clément, 2007; Carvalho, 2009). Furthermore, teachers are conditioned by the curriculum content, and their viewpoints affect their relation with the students, their teaching and the content to be taught (Leite, 2000).

There is a growing movement of fundamentalist religious groups aiming at introducing creationist ideas into curricula which interfere with regular science teaching of biological evolution, despite the opposition of scientists who support the evolutionary theory (Carvalho and Clement, 2007). These authors also consider that it is important to know the impact of the creationist viewpoint on curricula as well as the teachers' conceptions in different countries with distinct social and cultural backgrounds. According to them, the relation between science and religion differs greatly among countries, and religion in some countries can be a formal or an informal part of the national curriculum. The Council of Europe (2007) highlights the importance of maintaining biological evolution in science curricula, given its relevant place in current scientific knowledge, specially its unifying role in biology, and the need to fight for its maintenance in face of the creationist advance. This interference in favour of the creationism



teaching over biological evolution is illustrated by Nord and Haynes (1998) when they propose the inclusion of religious themes throughout the school curriculum.

Taking all this into consideration, the objective of this research is to understand how biological evolution is dealt within the biology curriculum in different State-Religion cultural contexts, in Argentina, Brazil and Uruguay. The use of curricula as a comparison parameter of educational systems of different countries was inspired by Pontes and Fonseca (2001), who have compared specific aspects of curricula of different countries. Also Carvalho and Clement (2007) justified the comparative analysis of curricula based on various studies in which the social background of the country had a strong influence on curriculum design regarding the topic "Evolution and the Origin of Human Beings".

Furthermore, Berkman and Plutzer (2011) have stated that citizens of a certain region want the curriculum adapted to their religious beliefs, blaming that the biological evolution theme should be avoided; those citizens even say that if they have lost the legal fight in the case of the United States, the creationist view will win the battle and so creationism will prevail in the classroom. This "victory", according to some authors, lies in the omission of biological evolution in classroom, the reduced time dedicated to it and the legitimization of creationist arguments by teaching through controversial themes, even if possibly not intentionally. For example, Journell (2013) claims that there is a significant number of studies on the teaching of this curricular controversial themes, so that biological evolution would be valuable theme in human and social sciences.

Teachers' attitudes and choices concerning a given subject depend on their personal conceptions as well as on the implicit and explicit theories in the school environment (Shim, 2013). The analysis of how the curriculum deals with specific themes and how the teachers react to the theme is a relevant field of research. Berkman and Plutzer (2011) propose the careful introduction of biological evolution into the curriculum to avoid attempts of imposing antievolutionary points of view. They mention that many of the investigated biology teachers in the United States reveal that they do not teach biological evolution or refer it only superficially. For some of these teachers, evolution is only a theory, not really true, and a necessary "evil" imposed by the curriculum and tested in exams compulsorily. In their study (Berkman and Plutzer, 2011) only 57% of the investigated American teachers considered biological evolution a unifying biological theory. For biologists, its importance is consensual, but for a significant part of the American population (40%) teaching creationism is as important as the teaching of biological evolution or even more important. The gap created by these distortions is hard to fill in (Trani, 2004), but the curriculum can contribute to minimize it. Anyway, in general, biological evolution when present in the secondary education biology curriculum has little relevance (Rutledge and Mitchell, 2002). Furthermore, about half of the American teachers have great difficulty in dealing with the curriculum place for teaching biological evolution and often prefer to balance it with the teaching of creationism or not to teach it at all (Blancke *et al.*, 2011).

In short, curriculum analysis can be a starting point in the investigation of how biological evolution is dealt in the three countries (Argentina, Brazil and Uruguay) since the emphasis that teachers give to the theme depends, in large measure, on the emphasis given in the curriculum.

Educational systems of Argentina, Brazil and Uruguay

The selection of Argentina, Brazil and Uruguay for the present study had in mind the distinct relations between State and Religion in these countries. Argentina has an openly Catholic constitution which requires the government to support Roman Catholicism



economically. This condition produced a historical symbiosis in culture, economy and politics between the Catholic Church and the Argentinian government, with very complex and intricate relations (Esquivel, 2003). In contrast, Brazil and Uruguay are formally secular states when it comes to their constitution, but Brazil is indeed secular only formally since Catholics and Evangelicals have great influence and impact on policies. Recently, suggestions to teach creationism in Brazilian schools have been made by evangelical politicians (Silva, 2015). Uruguay, on the contrary, displays a consolidated secularism, where religion plays very little role in political affairs (Oro, 2008). This process of laicism in Uruguay has been very distinctive when compared to other Latin American countries. It has its roots in the XIX century, and the total separation between State and Religion occurred in the Constitution of 1919 (Silva & Fontenele, 2007).

All these three countries belong to the economic block MERCOSUR but they have differences in a whole set of public policies and developmental policies, which contributes to differentiate them sharply (Souza, 1995). This gave rise to the need to investigate the dimension of these differences and to categorize them, which may contribute to a more successful regional integration. Indeed, one of the great challenges in the construction of an economic block is to take into account the cultural, political and educational specificities of each member state, with their distinct relationships with the religious environment (Lampert, 1998; Cunha, 2000). Piletti and Praxedes (1998) have compared data of MERCOSUR countries and found disparities in the education, economic and social areas. Their findings on the main social indexes showed Brazil in the worst position, although it has the highest percentage of investment in education, research and development.

According to the Comparative Analytic-Descriptive Study of MERCOSUR Educational Sector (Anísio Teixeira Institute, 2005), the educational system of the three countries is characterized below.

Argentina

Argentina has a centralized administration and underwent a great change in the last years with the transfer of the educational systems to its 23 Provinces. In 2006, the new National Education Act (26.206) changed the system back to the previous four levels of education: Initial, Elementary, Secondary and Higher education. (These levels may have different names in some Provinces, due to the national decentralization system).

Initial education is for children aged from 0 to 5 years old, with the last year being compulsory. Elementary Education is composed of six academic years and it is compulsory for children aged 6 years and older.

Secondary Education is composed of six academic years and became compulsory with the National Education Act (26.206) and is for adolescents and young adults who have completed Elementary Education (13 to 18 years old). All the modes and guidelines of Secondary Education aim at preparing pupils for the full exercise of citizenship and for either work or follow further studies. Secondary Education is divided into two cycles: Basic Cycle (three years), common to all kinds of courses, and Specialized Cycle (three years), the content of which varies with the areas of knowledge and the social and work worlds.

The undergraduate education system of Argentina is complex and heterogeneous. In more than 100 universities there are about 1.6 million students, being 80% of them in public universities and 20% in private ones. The public universities are free and require competitive application (Coraggio; Vispo, 2001).

Brazil



The Brazilian educational system has recently undergone a democratization process, especially during the 80's of the last century (Rosemberg, 1992), with higher degree of autonomy and decentralization of educational policies. The educational system is divided in Basic Education (which comprises Child Education, Elementary Education, and Secondary Education) and Higher Education.

Municipalities act mainly in Child and Elementary Education whereas Brazilian States act in Elementary and Secondary Education. The federal government provides mainly technical and financial support to its 26 States and organizes and promotes the Higher Education.

Child Education serves children up to 3 years old in day-care centres, and between 4 and 6 years old in kindergartens. Elementary Education is compulsory, starts at 6/7 years old and lasts for eight years, up to 13/14 years old.

Secondary Education is for three years (14/15 to 16/17 years old) and provides general education for further Technical Education or Higher Education.

Higher Education, in public or private universities and institutes, provides undergraduate courses in the various professional fields and is accessible to those who have completed Secondary Education and passed selection examinations. In addition to undergraduate studies, universities also have post-graduation courses providing master and doctoral degrees. Public schools are free.

Uruguay

In Uruguay, education is based on the principles of secularization and equal opportunity. Secularization is expressed in:

...the thorough and critical study of all subjects in public education through free access to sources of information and knowledge that enable learners to take a conscious position. The plurality of opinions and rational and democratic investigation of knowledge and belief is ensured. (Ley General de Educacion 18437, 2008, disponible: <https://www.impo.com.uy/bases/leyes/18437-2008>).

In order to ensure equal opportunities, the Uruguayan constitution establishes free access to the 12 years of education, from initial education, starting at the age of four, up to middle basic education. The educational system is organized in the following levels: Initial (three academic years) and Primary Education (six academic years), Middle Basic Education (three-year unified basic cycle), Upper Middle Education (three academic years) (including general, technical and technical-professional education) and Tertiary Education (including non-degree technical courses, university-level technical courses and higher technological education and higher education) and graduate and post-gradual courses. The Initial and Primary Education, Secondary Education, Professional Technical Education and Elementary and Secondary Teacher Training are subordinated is regulated by a five-member Central Directorate Council, with three of its members appointed by the President of the Republic. In contrast to other countries in the region, the Ministry of Education and Culture exerts no political power on public Higher Education.

Middle higher education comprises three-year courses leading to university admittance. After a common first year it branches out into four basic areas in the second year (Biology, Humanities, Science and Arts Expressions) and into seven branches in the third year.

Technical Education aims to offer a fast track into the work market; it can last from one to seven years and has distinct modalities grouped in four areas: agriculture, industry, arts and



handicrafts and services. It leads to professional technical education with a broad range of programmes and designs according to the level of specificity of the area of education offered.

Tertiary or Higher Education is provided by public and private universities, private university institutes and public and private non-university tertiary institutes. The “Universidad de la República” was the only university in the Uruguay for 150 years, but in the last twenty years the government allowed the creation of private universities (four so far) based on the principle of greater freedom of education. These private universities are not associated with the public university by any means and they are not under any control of quality by the State.

MERCOSUR data

Data of the Comparative Analytic-Descriptive Study of MERCOSUR Educational Sector (Anísio Teixeira Institute, 2005) points out similarities and differences among these three countries. It reveals a general decrease in the levels of illiteracy, with outstanding success in Uruguay and Argentina and relative failure in Brazil. School child enrolment increased in the three countries (100% in Uruguay, 7% in Argentina and 3% in Brazil), but not so much at the upper levels of schooling, particularly from ages 12 to 14 years old, indicating high levels of school dropout. The contradiction of the Brazilian educational system lies in its co-occurring higher levels of approval to progress to the next grade and, at the same time, of dropout. Brazil and Argentina have the greatest numbers of students per class in Primary Education, but this tends to decrease in Secondary Education. Argentina has the lowest indexes of school failure within MERCOSUR countries, Brazil index is twice as compared to Argentina's and Uruguay is in between. Data also reveal that despite Brazil's greater investments in education, its results are relatively poorer compared to the other two countries.

Similar problems in the education systems of MERCOSUR member countries, especially in the 80's, have also been reported by Rosar and Krawczyk (2001), with particular attention to Argentina, Brazil and Uruguay. Moreover, given the particularities of the constitutional origins of the national states, social behaviours and educational organizations, these authors point out that those interesting differences and possible repercussions in the field of education deserve further study. The authors also call attention for the role that comparative analysis may play in the identification of conceptual difficulties and the need to know the concrete reality of the educational systems in Latin America, particularly in MERCOSUR countries.

A relevant aspect to consider is that there is no neutrality in the role of religions, and churches as a whole in Latin America due to their historical importance in the construction of these societies. They exert a major influence in various sectors, such as in politics and education, an influence that may reach school curricula. Even in the self-claimed secular state of Uruguay, the separation between the State and Religion hardly occurs in practice (Mariano, 2006). Indeed, Oro (2008) reported the existence of discriminatory treatment, either negative or positive, depending on politics, but always associated with various country's own historical and cultural phenomena. The author points out that the best example is the Catholic Church, which has a differentiated treatment due to its historical-cultural role in Latin America. Indeed, two structures that seek to regulate society can be found in these countries, the Catholic Church and the State, with a winding and contradictory path that accommodates tensions in a complex relationship (Esquivel, 2003). Thus, the Catholic tradition is at the heart of this subcontinent identity and the root of its unity (Figueiredo-Cowen and Gvirtz, 2009). It is in this complex context of religious influence in Latin America that the creationist hypothesis and the "intelligent design" (with its pseudoscientific manifestations) have been growing. Their supporters see biological evolution and creationism as two incompatible points of view, which



is becoming a problem for science education in Latin American countries (Cornish-Bowden and Cardenas, 2007).

It is in this context that the present study intends to analyse the educational curricula of the Latin American countries, Argentina, Brazil and Uruguay, which have different levels of relation between State and Religion.

Methodology

Countries selection for analysing biological evolution in school curricula

The criteria for the selection of these three Latin American countries (Argentina, Brazil and Uruguay) for the comparison of the theme biological evolution in the curricula was based on the different models of relation between State and Religion in these countries. The high level of influence of religion in Latin America countries can be observed when only seven out of twenty countries do not mention God in their constitutions (Oro, 2008). According to Oro and Ureta (2007), this strong influence can obfuscate the religious diversity in the American subcontinent, with a certain prevalence of Christian faith.

The analysis of evident contrasts in the legal relationship between the State and Religion of Latin America countries (Oro, 2008) provided good elements for the selection for this study of Argentina, Brazil and Uruguay. Indeed, Oro (2008) reported three distinct types of legal order: countries with a State Church regime, *i.e.* with an official religion (**Argentina**, Bolivia and Costa Rica); countries that define the separation between the Church and the State (El Salvador, Guatemala, Panama, Paraguay, Peru, Dominican Republic and **Uruguay**); countries with separation between the State and Religion and providing equal rights to all faiths, but that in practice give special privileges to the Catholic Church (**Brazil**, Chile, Cuba, Colombia, Ecuador, Haiti, Honduras, Mexico, Nicaragua and Venezuela).

In his study, Oro (2008) reports that 88% of the Argentinians are Catholic, 8% Evangelicals and 4% other religions or non-religious persons; in contrast, only 52% of the Uruguayans are Catholic, 2% Evangelicals and a large proportion of 46% are included in other religions or non-religious persons; Brazil is between these two countries since 74% are Catholic, 15% Evangelicals and 11% other religions or non-religious persons.

The high predominance of Catholics in Argentina, the Brazilian growing influence of Evangelical groups (Mariano, 2001) and the Uruguayan high number of other religions or non-religious people, were the main reasons for selecting these three countries for the analysis of their school curricula on biological evolution.

Document analysis

Curricula of Secondary Education (grades 10 to 12, *i.e.* 14/15 to 16/17 years old pupils) available on line in the education sector of each country were analysed, giving particular attention to the parts regarding biological evolution. In the case of Argentina, the curriculum of Buenos Aires (the main Province of the 23 Provinces) was analysed in detail but curricula of other Argentinian Provinces were also analysed. In Brazil, the curriculum of Minas Gerais State (one of the 26 Brazilian States, with larger population and greater economy) was used. Uruguay, being a small country, has a single and unifying curriculum which was analysed in this study. Not only the official curriculum but also curriculum-related documents from the ministries of education or equivalent documents, such as curriculum guidelines and concerned legislation were also analysed. In addition, other authors' papers of these three countries on this issue were also used as documental sources.



Content analysis was the methodology used in order to identify educational tendencies of the objectives, contents and methodology of biological evolution teaching and the discussion of its role and importance in the curriculum, as suggested by Pontes and Fonseca (2001).

The curricula parts referring the topics of biological evolution, life origin and human origin were considered in the comparative study among countries. Particular attention was given to the educational goals (Kelting-Gibson, 2005) as well as to the “hidden curriculum” (Kently, 2009), since sometimes the curriculum seems to indicate some idea but the implicit idea can be a different one. This conception of “hidden curriculum” is especially important when it deals not only with controversial themes like evolution, life origin and human origin but also with different countries and cultures (Carvalho et al, 2008).

Results and discussion

Argentinian curriculum on biological evolution

Argentina National level

It has been difficult to define and implement secondary education curricula in Argentina promoted by the national government due to the previously mentioned Provinces decentralization and autonomy. This has led to the emergence of contradictions and conflicts regarding the theme biological evolution, as referred:

In Argentina, the teaching of the evolution theory has taken a path filled with conflicts, biases and errors. [...] Nevertheless, when we analyse the study plans and programmes approved by the Ministry of Education for the teaching of biology in secondary school during the second half of the 20th century, we observe that the contents related to the living beings evolution were left out until 1972 and they have hardly appeared after that, and when they do, they are a separate topic in the end of the 4th year programme". (Massarini *et al.* (2007, p. 3).

In the neoliberal educational reform carried out in the 1990s, biological evolution was finally incorporated into the Common Basic Concepts (CBC) of the old polytechnic (secondary) level. However, some authors (Gvirtz and Valerani, 1999) claim the Catholic Church managed to have some contents eliminated from the curriculum. Furthermore, Gutierrez (2009) refer that in the so-called "Sources for the transformation of the Natural Science curriculum", biology-related contents were written by individuals from fields other than biology and that the names of Lamarck and Darwin were eliminated from the curriculum and, subsequently, those individuals had to ask their resignation to the Ministry of Education (Gutiérrez, 2009, p. 100). In the last reform of 2006 the topic biological evolution appears as one of the teaching axis in several documents, indicating that the stress for not including biological evolution was useless.

However, after the 2006 reform, the curriculum design in biological evolution has become again in trouble, even in 2008 when the "Year of Science Education" was declared. More recently, in 2011, the Priority Learning Nucleus has been established for Secondary Education national level), which, among other things determines the teaching of biological evolution in grades 2 and 3, the priority concerning living beings should be:

...the approach of the historical development of scientific theories that explain the evolution of living beings and the interpretation of the idea of natural selection proposed by Darwin based on the contributions from

genetics to explain the evolution of the species. (Ministerio de Educacion, 2011a, p. 19).

For the secondary cycle science specialization (grade 10), two axes have been established for the biology subject "evolution processes", indicating how the subject should be taught:

"the depth and understanding of the models that explain the evolution processes of living beings from a historical point of view, with emphasis on the identification of the sources of genetic variability in natural populations under the Synthetic Theory of Evolution. (Ministerio de Educacion, 2011b, p. 5).

Although these guidelines from the National Ministry of Education for the Argentina Provinces refer to Darwin and the Evolution Theory, several crucial aspects have not changed in many Provinces, which has been largely criticized (Gutierrez, 2009). Indeed, references to Darwin and his work related to Evolution theory are scarce. In addition, Evolution is no longer used as a unifying basis for the integration of biology education and has been reduced to contents related to biological diversity. Is biological evolution not necessary for integration of other biology subjects?

Province of Buenos Aires

The analysis of what occurs in the 23 Provinces reveal a rather more complicated picture. The Autonomous City of Buenos Aires has always been considered more progressive, although in the last five years the government has had a conservative ideology and practice, and, consequently, a position much closer to that of the Catholic Church. The official document entitled "Biology Content for Secondary School" mentions that one of the general teaching goals is:

...to promote the interpretation of the life phenomenon as the result of a natural evolution processes, which represents common characteristics to all organisms. (Ciudad Autónoma de Buenos Aires, 2009, p. 6).

However, there is only one reference to the diversity of living beings in a document entitled "*Biodiversity as a result of evolution*" (p. 9). As previously mentioned, biological evolution is not presented as the main axis of the discipline and it is not taken into account in subjects other than biodiversity.

The secondary school curriculum of the Province of Buenos Aires (Bracchi and Paulozzo, 2011) indicates that this level of education must prepare the students for higher education and for it, subjects, contents and approaches must be selected with this objective in mind. This curriculum emphasizes that science must interpret reality and not just represent it, which leads students to evaluate this aspect in relation to the scientific theories and models in the development of science. The permanent construction and interpretation of science is also pointed out. Furthermore, it is proposed that the value of observation must be relative, rather than absolute, because it depends on the theory that guides the observer; analysis may lead to a series of interpretations and consequences when the controversies involving biological evolution education are taken into account. In this same perspective, the document calls attention to the fact that there are various scientific methods, rather than a single one, and that scientific research is marked by specific interests most of the time.



The loss to the teaching of biological evolution leaves ample room for the previously mentioned hidden curriculum because of the questions raised on the evolution theory that may be answered according to the teachers' personal beliefs and conceptions. The Argentinean curriculum guidelines is based on the inquiry-based science education concept, with the notion that constant questioning may lead the student to construct knowledge through reflection and action and to a critical view of concepts and of the surrounding world (Chiappetta, 1987). The greatest problem is that biological evolution is a process that integrates the whole discipline and if students develop explanations that exclude it, it is possible that they will have great difficulty in understanding biological processes (Mayr, 1998).

Moreover, Bracchi and Paulozzo (2011) claim that the curriculum of the Province of Buenos Aires indicates concepts related to biological evolution that must be studied and that human evolution must be presented with supporting theories and evidence. The origin of the species is a suggested curriculum contents, but there is neither reference to Darwinism theory nor to its fundamental principles, although it refers to "*The mechanism of evolution under debate: alternative models to explain the evolutionary change*" (Bracchi and Paulozzo, 2011, p. 26).

Even in the Argentine Province of Buenos Aires, which many consider the most liberal in the country, does not indicate the best accepted theory to explain evolution, *i.e.* the Darwinian Theory. Nevertheless, the equivalent minimum content for secondary school suggests presenting alternative explanations for evolution. The genetic bases of evolutionary change are indicated, but well-established supporting scientific evidence of the Darwinian Theory is not indicated for clarification, such as palaeontology, embryology, comparative physiology and others, none of which are mentioned in the suggested minimum curriculum content.

Provinces that are more conservative than Buenos Aires tend to keep away the most sensitive subject in relation to the teaching of biological evolution in curriculums, the theories of origin of life and human evolution, because it is possible to insert themes more or not relevant in each province (Ruiz and Schoo, 2014).

Province of Mendoza

The natural science curriculum of the Province of Mendoza (Quinteros, 2008) has only two pages dedicated to biology, among one hundred twenty pages, with no reference at all to Evolution. Therefore, students of secondary school (grades 10 to 12) in this Province have little contact with these subjects, which has been considered the orienting axes in biology education (Dobzhansky, 1973). In grade 11 very limited reference is made to biological evolution with a Darwinian focus. In grade 12 Darwin is not mentioned but there is some indirect reference to biological evolution associated with other topics. Natural selection is mentioned as a hypothesis: "Natural Selection as a central hypothesis of the Evolution Theory" (Quinteros, 2008, p. 132). In this same part of the curriculum, the only reference to biological evolution is an indication of what students should learn, without any reference to the Darwinian Theory:

Interpret the main characteristics of the dynamics of the natural processes that occur in the biosphere.

Analyse the hypothesis on the origin of life and the current theories that attempt to explain it.

Analyse the challenges of human development, especially the environmental deterioration processes and the alternatives for the management of biosphere resources. (Quinteros, 2008, p. 131)

In short, in Argentina, Evolution has been incorporated as a central theme in the teaching of biology, but it is limited to contents related to organisms diversity and, in some cases, barely incorporated, and when so in the form of questioning. We consider that it is extremely complex for students to understand the biosphere natural processes or the origin of living beings if they do not understand biological evolution and its mechanisms accurately. The result of this situation in Argentina in relation to the teaching of biological evolution and, consequently, biology education, is also cause of great concern for many authors (Gvirst and Valerani, 1999).

Brazilian curriculum on biological evolution

Brazil National level

Brazilian educational system bears resemblances to those of other Latin American countries (Sguissardi, 2002). Changes in the education guideline have been introduced in 1990 by the State administrative-managerial reform, involving the expansion of higher education, mainly the increase of private institutions. The number public schools has increased as a result of the programme “Restructuring and Expansion of the Brazilian Federal Universities”, which also determines regulatory and control measures associated to the university autonomy.

As previously mentioned, Brazil is officially a secular country, but the Catholic and Evangelical Churches have strong influence on politics, particularly in education, a fact that contradicts the country's supposed secularism (Oro and Ureta, 2007; Oro, 2008). In contrast, the number of those who do not follow a religion has increased recently (Mariano, 2013).

The National Curriculum Parameters for Secondary Education (PCNEM) propose the contents that must be taught but with no intention of setting a national norm (PCNEM, 2000). This document links general competences to the contents of the secondary school subjects and propose educational practices for the school curriculum organization. In sum, it establishes themes that structure the subjects to be taught in secondary education and specifies that proposed contents must not be a plain list of topics to be considered as a minimum curriculum. The document refers that its proposals are neither mandatory nor unifying, but rather a broad view of the work to be done in each school subject.

PCNEM introduces Evolution in secondary school Topic 6 as "*Origin and evolution of life*" (PCNEM, 2000, p. 21), which is characterised as one of the most instigating themes for human beings because of the polemics that surrounds it and the various interpretations that it provokes. It is worth to point out the passage that says that the teacher must afford opportunities of confrontation the different explanations of the subject elaborated at different times, the scientific, the religious and the mythological views. It is interesting to observe that there is no indication of which explanation should be emphasized and approached based on a solid set of evidence. The brevity of scientific knowledge is highlighted but it also proposes that students get familiarized with the mechanisms of life evolution, especially human evolution. Finally, it indicates that cultural and biological factors interact in the evolution process and that human interventions supported by scientific and technological knowledge change the course of the evolutionary process.

Among the Evolution units presented in the PCNEM, the "Hypotheses on the origin of life and primitive life" unit refers that students should learn the explanations on the origin of the universe, the Earth and living beings and compare them with conceptions from other sources from different moments in history. It also proposes that students should learn about scientific experiments and arguments that defeat the spontaneous generation idea. It suggests the use of models, drawings and charts to demonstrate the probable phenomena that led to the development of life and the primitive atmosphere conditions.



This Brazilian PCNEM, like the Argentinean national guidelines, is based on the inquiry-based approach to science education. It is based on the notion of the need to develop skills to formulate questions, that the students should be able to use models and explanations to carry out investigations, as well as understand how scientists construct scientific knowledge as proposed by Keys and Bryan (2001).

Evolutionary ideas and biological evolution are referred to in another PCNEM unit (Evolutionary Ideas and Biological Evolution, page 51), which proposes the comparison of Lamarck's and Darwin's points of view, the explanations of Evolution, mutation mechanisms, genetic recombination and natural selection. Environmental factors that interfere with individual genetics are referred, and so is the comparison of gene frequency in the evolution process. It also proposes plotting the lines of evolution, the analysis of phylogenetic trees and a time line pinpointing relevant facts in the history of life.

The Brazilian PCNEM also contains a unit (“The origin of the human being and the cultural evolution”, page 51) related to the origin of the human beings and its cultural evolution. This item proposes plotting the phylogenetic tree of humans based on evidence and pointing out the roles of intelligence, language and learning in human evolution. Cultural evolution should be differentiated from biological evolution anchored on learning and the transmission of learned features, and related to modifications in gene frequencies. The benefits and disadvantages of environmental changes and the adaptation of animal species of interest to human beings, taking into account events that took place over the last million years of human history and the future of the human species should be discussed.

Another document related to the Brazilian curriculum is the National Curriculum Parameters (PCN) that proposes considering the reality and diversity of the Brazilian Federation (PCN+, 2000). For such, the curriculum must be flexible and able to embody various pedagogies and at the same time have a high level of accuracy, indicating the competencies that secondary school students must acquire. Actually, the Law on Brazilian Education Guidelines (LDB, 1996) had anticipated this great margin of flexibility in contents and methods for better school outcomes. Therefore, the State departments are the decision-making for educational policies for their secondary schools, such as the curriculum design and implementation. This flexibility intends to produce decentralization and collaboration among the agents involved, leading to school autonomy to define the pedagogical proposal, with all advantages and risks.

This autonomy and freedom in the curriculum design brings about virtues, such as the possibility of improvement and adapting it to the regional and local reality (Moehlecke, 2012). However, some risks behind the decentralization process characteristic of the Brazilian curriculum policy have been pointed out by Castro (2007), especially a poorly disguised lack of interest from the government in popular education. Furthermore, the possible disregard for secular education imposed by municipal and state political forces that want to give visibility to religious themes that notably oppose the teaching of biological evolution in favour of the creationist dogma or the intelligent design in the school context can also occur (Martins, 2001).

State of Minas Gerais

Since the 26 Brazilian states have a well-known autonomy concerning curriculum proposals, this paper presents how biological evolution is treated in the curriculum in one of the states, the state of Minas Gerais. This State has a quite heterogeneous working conditions and, although being one of the richest regions in Brazil it is also one of the poorest population. According to the results in national and international exams, the quality of its basic and secondary education is relatively good in comparison to Brazil as a whole.



The document Curriculum Basic Contents (CBC) of Minas Gerais State, produced by Martins et al. (2006), establishes the biology contents, providing various suggestions and observations for secondary education (grades 10 to 12). The theme "History of Life on Earth" must be dealt with biological evolution over the years of secondary education: in the first year (grade 10), evolutionary theories by Lamarck and Darwin and the explanations of evolution based on evidence; in the second year (grades 11), the mechanisms of evolution; and in the third year (grade 12), a long programme from human evolution to the hypothesis on the origin of life.

Biological evolution appears right in the beginning of the document (Martins et al., 2006) referred to as "transformations" along with indication of two influencing factors: natural selection and adaptation. The mechanisms that lead to genetic diversity are cited: mutation, sexual reproduction and genetic recombination. The CBC document refers "History of Life on Earth" as one of the fundamental axes of biology and recognizes the importance of biology evolution (Martins et al, 2006). This document further states that there are strong arguments that support the evolutionary aspects of living beings and that they participate in the structuring of modern biological thinking, but it uses the term "adaptation" rather than evolution as a key idea for the understanding of biology. It also shows that there is proof for these processes, such as fossils, and that extinction seems to be the rule; therefore, adaptation and natural selection must be considered as being fundamental in the understanding of the history of life on Earth (Martins et al, 2006).

CBC document also shows the risks of Evolution misunderstandings based on the students' previous knowledge. It discusses a possible simplistic and anthropomorphic view that students may have. Common sense ideas are presented, such as the perception of evolution as progress, improvement or enhancement, views that are distant from that of biological evolution. It suggests that this may be a fruitful theme for the understanding of how scientific ideas are constructed, through evidence, models and reinterpretation of facts (Martins et al, 2006). In this same line of reasoning, it points out the risk of the students viewing biological evolution as a process in which plants and animals modify themselves in response to the environment. However, it proposes that it is possible to contrast these previous conceptions with scientific terms such as theory, hypothesis testing, evidence and others (Martins et al, 2006).

In brief, the Brazilian curriculum has experienced the impact of reforms in the 1990s, with strong influence from the World Bank and international evaluation processes, in order to decentralize and to bring autonomy to the 26 Brazilian States. The national curriculum has become just a guideline for the development of the State curricula. The national guidelines refer the teaching of biological evolution, considering the possible controversies about it. Decentralization may have been a breakthrough, because it allowed for a focus on specific regional issues in an immense and diverse country such as Brazil. However, this decentralization has caused some risks, especially in state governments with religious influences, which can use this freedom to insert creationism and intelligent design, as it has been tried earlier in the State of Rio de Janeiro (Jamil, 2004). In the State of Minas Gerais curriculum, *i.e.* in the CDC document, no religious influence (creationism and/or intelligent design) was found, on the contrary, the fundamental points of the Darwinian evolutionary theory are proposed to be treated in secondary school, including the evidence of its occurrence.

Uruguay curriculum on biological evolution

Uruguayan National level

There are few studies on general education in Uruguay, particularly studies that sought to interpret the progress in the last decades of education both in curriculum and in classroom.



Therefore, any approach that allows for the analysis of some of these aspects is an important contribution to the knowledge of biology education in Uruguay. Since the 1990s the Uruguayan elementary, secondary and technical-professional curriculum design has undergone various reformulations.

At all levels of secondary education, the national curriculum produced by the “Consejo de Educación Secundaria” (CES, 2014) establishes quite explicitly the education objectives, contents (concepts and procedures) and results expected from education. Almost all units focus on functional biology teaching, in agreement with what Mayr (1988) called "proximate causes" that answer questions that are fundamental to science: how does it work? Particularly, in basic secondary education (grades first and second of Upper Middle Education) there is no conceptual contents that proposes the analysis of living beings characteristics, such as: why they have a certain form and not another, why it works in one way and not in another, gaps that can be filled when biology evolution is used as the biology education axis. Therefore, the inclusion of concepts linked to biology evolution depends exclusively on the biology teacher since the curriculum implementation does not establish rules for its inclusion. It is important to point out that the theoretical concept that supports the curriculum for each level states that the concept of science is present in education as part of the ‘hidden curriculum’ and that it is conveyed when the meaning and intent of scientific theories and models are worked on (CES, 2014). As previously mentioned, in contrast to other countries in the region, biology teacher training (as well as other teachers' training) does not take place at the university. As a result, research is not included as a teaching strategy in the education of future teachers; only epistemological aspects are analysed theoretically and without bringing them into practice. This can influence not only the teachers' conceptions of science and technology, but also their teaching strategies.

The upper secondary school (first grade of Upper Middle Education) corresponds to the first year of the general Biology teaching course, and the first unit proposes the analysis of various theories on the origin of life, the historical context of their development and of divulgation through the main experiments related to the issue. It especially introduces pre-biotic and cellular evolution concepts. However, when the academic results proposed by the established curriculum and the reports of interviewed teachers are analysed, they show that the teaching of evolution remains focused on functional biology, on processes that describe experiments and structures, without a tie to the biological concepts of Evolution and natural selection (CES, 2014). The second unit of the first grade of Upper Middle Education proposes the understanding of the universality of the genetic code and the consequences of mutations. However, there is no reference to biology evolution nor the genetic code is considered as evidence of evolution or mutations in biodiversity. Again, the descriptive point of view of biological processes is evident and based on "proximal causes" (CES, 2014). Especially in this unit, a kind of "regression" seems to have occurred in relation to the teaching of biological evolution since the previous plan of 1976 indicated curriculum contents on Evolution (evolutionary theories, the concepts of species and populations, evidence of Evolution), which has been replaced by biotechnology-related contents.

In the second year of upper secondary school (second grade of Upper Middle Education), the biology curriculum axis is the study of biodiversity from an "evo-devo-evolutionary" approach, *i.e.* evolutionary biology of development, which studies mechanisms and sequences of embryonic development comparatively and thus seeks to understand how genes produce new forms, functions and evolutionary behaviours. The focus is the study of natural environments of Uruguay (CES, 2014). Once more, at no point of the curriculum mentions the causes of biological diversity, but it does focus on the teaching of flora and fauna contents and their preservation. The learning outcomes are: *"To establish the evolutionary*



sequence for the animals studied" (CES, 2014, p. 7), which is underlined by a Lamarckian view of the evolutionary process, in a straight sequence line, as a zoological ladder. Another objective to attain is *"To explain the adaptive value of the structures observed and their evolutionary meaning at population level"* (CES, 2014, p. 7). Although at first this objective might be considered closely linked to natural selection and adaptation, as a process and their results, none of the conceptual, procedural contents or the proposed activities in this or previous units present themes that are required to attain this objective. Similarly, when the aquatic zone environment is analysed at this level, various conceptual contents are related to forms of adaptation (to fly or aquatic environment vegetation), but not even in this case the concept of adaptation is emphasized with an evolutionary focus. Instead, it looks at the characteristics that allow organisms to inhabit a certain environment. Thus, a teleological vision of evolution continues to be strengthened in a general way.

The Humanities option of Uruguayan national curriculum of second grade of Upper Middle Education also includes aspects associated with the evolutionary process, particularly human biological and cultural evolution. The first unit prescribes conceptual contents on the comparative study of apes and human beings, as well as the analysis of human and brain evolution processes, among others. The objective of this unit is *"to acknowledge the evolutionary characteristics of human beings"* (CES, 2014, p. 8) where it describes the new characteristics but does not focus on the natural selection process and the adaptive advantages of biological innovations.

The Uruguayan curriculum, like those of the other two countries (Argentina and Brazil), suggests that teachers must conduct learning through exploration, including through constant practice and questioning. The process must be coordinated by the teacher through experimentation and dialogue with the theory, which should lead to a change in the teaching method (Keys and Bryan, 2001).

The Uruguayan curriculum is more descriptive, being regulated by the central Education Administration for all public and private institutions. It is more accurate and objective, particularly regarding the origin of life and Evolution as compared to the other two countries. The extensive and ambitious curriculum of all school levels determines that the teachers have to shorten the contents in face of the scarce weekly class time, which is not always followed by pedagogical argumentation. Nevertheless, the Uruguayan general curriculum indicates more clearly the theories of the origin of life and biological evolution, while the other countries leave it up to the Provinces and States, in Argentina and Brazil, respectively.

In short, it could be expected that consolidated secularism in Uruguay, both at the state and social levels, could favour (or do not hinder) the teaching of biological evolution in the official curriculum. However, in the Uruguayan curriculum, strongly prescriptive at the national level, for both public and private institutions, the contents linked to the teaching of evolution are scarce. Thematic units, such as origin of life and origin of humans are explained, although they focus on the description of the temporary changes in the process of hominization or classic experiments on the evolution of ideas with respect to the origin of life. There are no thematic units focused on understanding the natural selection model as an explanation of the evolution of living beings at any educational level. This invites us to reflect on what could be the reasons for the absence of this issue in school teaching; there may be multiple reasons, but the absence of biology evolution in initial teacher training can be one of the major reasons.

Conclusions and implications for teaching

Curriculum decentralization and flexibility is clearer in the Argentinean and Brazilian curricula than in the Uruguayan curriculum, justified by the large territory extension together



with the multiculturalism of both countries. Either Argentinian 23 Provinces or Brazil 26 States are allowed to decide on the contents and emphasis to be given in their school curricula. Regarding polemic themes, such as the origin and evolution of the human being, flexibility may result in local curriculum proposals that neglect biology evolution based on religious perceptions, which has been detected in both countries. The main theories involving the origin of life and evolution are not highlighted and the interim scientific knowledge is pointed out in Argentinean and Brazilian general curricula. The particularities of the themes to be taught in school are left up to the Provinces and the States curricula, respectively. This may produce a cycle of lack of contact with biology evolution that will hamper students' scientific education and can result in teachers with a lack in a central topic in their training, which in turn will carry consequences on their teaching classes.

Being a small country, the Uruguayan curriculum is used at national level and the teaching of biological evolution in secondary education stands out for its clear indication of biology evolution. Being the same curriculum in the whole country, the influences of local religions is rather lower when compared to Argentina and Brazil.

A close analysis of the three countries curricula showed that biology evolution is not considered as a guiding axis in biology education. Even if it is included in isolation through some concepts associated with evolution, it is evident that there is an underlying teleological and linear conception.

In general, the Argentinean, Brazilian and Uruguayan curricula propose inquiry-based science education approach, being more evident in the Argentinean and Brazilian documents. Indeed, they follow these three key points concerning inquiry-based education (Chiappetta, 1997; Keys and Bryan, 2001): *(i)* to lead the students to make inquires and reflect on the work conducted as they acquire knowledge on the investigated theme; *(ii)* investigate and include previous planning; *(iii)* conduct the activities, interpret the obtained results and only then draw a conclusion. The curricula propose that classes are foreseen to be guided towards formulating questions to be used in the study of polemic themes, such as biology evolution. According to these curricula guidelines, the students' previous ideas and their historical and cultural conceptions as well as the method of construction of scientific knowledge must be taken into account in the teaching process.

It is necessary to reflect on the advance of creationism, which has been considered a threat to science education, especially if biological evolution is not considered a fundamental theme in the national curriculum (Council of Europe, 2007). An example of this threat occurred recently in Brazil when a law project, PL8099/2014, authored by one of the best voted federal congress representatives and a representative of evangelicals, whose amendment "*introduction of creationist contents in private and public-school curriculums*" was presented on November 13, 2014 (<http://www.camara.gov.br/proposicoesWeb/fichadetramitacao?idProposicao=777616>). Religious tolerance, something desirable in the school environment, must not mean giving the same emphasis to dogmatic knowledge in biology classes and teachers must bear this in mind in agreement with the curriculum. One of the ways to deal with the conflicts proposed by Blancke *et al.* (2011) would be introducing the history of science to teacher training to help teachers with issues related to the science and religion dilemma.

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