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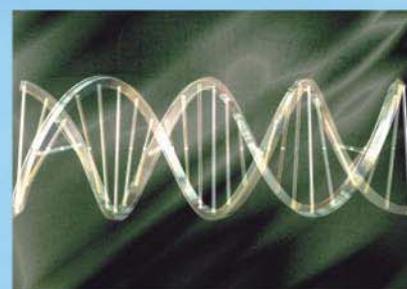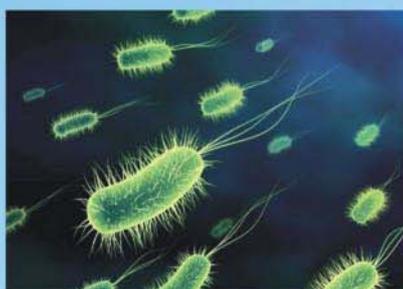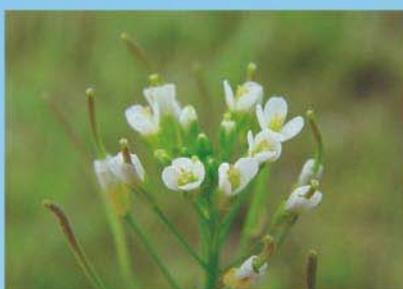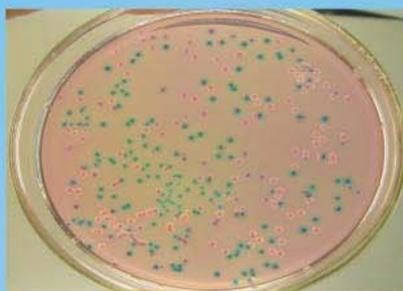
From Knowledge to Wisdom

Creationism and Evolution Views of Brazilian Teachers and Teachers-to-Be

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Abstract: This paper aims at assessing the evolutionist and creationist conceptions of Brazilian teachers. The work is developed within the framework of the European project BIOHEAD-CITIZEN (biology, health and environmental education for better citizenship), which takes into account that scientific knowledge and teachers' attitudes and values can influence the teaching practices. The large questionnaire BIOHEAD-CITIZEN, which was constructed to be applied in 19 countries in Europe, Africa and Middle East countries, was applied, in this study, to six groups of Brazilian teachers: primary school teachers, biology teachers and Portuguese language teachers and corresponding teachers-to-be. For this paper the answers to questions about evolution were used as dependent variables. Descriptive and multivariate analyses were carried out. Biology teachers and biology teachers-to-be gave more importance to the natural selection and the evolution process than the other groups of teachers. Comparing to the BIOHEAD-CITIZEN countries, the total Brazilian sample showed a higher percentage of creationist conceptions, particularly the Brazilian biology teachers and teachers-to-be. As discussed herein, this may not be an obstacle for teaching evolution as they accept both creationist and evolutionist concomitantly.

Key words: Teaching biology, biological evolution, creationism, Brazilian teachers, teachers-to-be.

1. Introduction

The assessment of teachers' conceptions on evolution is important because it allows to understand, for example, how they cope with issues related to the confront creationism *versus* evolution inside the classroom. As referred by Meadows, Doster and Jackson [1], these issues can cause disturbance to American biology teachers who think it crucial for the students to learn biology evolution without questioning about their personal and community values or the world vision, which can be in opposition to the evolution theory. Similarly, teachers need to cope with their own distress triggered off from conflicts between evolution and their religious beliefs and personal values.

This work is developed within the framework of the European project BIOHEAD-CITIZEN [2, 3], aiming to improve understanding of how different aspects of citizenship are promoted or may possibly be promoted through BIOHEAD-CITIZEN. This project takes into account not only that scientific knowledge on these topics develops itself fast but also that teachers' attitudes and values can influence the school practices. A questionnaire was constructed, translated and validated to be applied in the 19 countries with geographic, historical, cultural, social, religious and political contrasts: European, African and Middle East countries. Some results on teachers' evolutionist and creationist conceptions can be found in Refs. [4-8].

This current paper extends the BIOHEAD-CITIZEN

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project to a South American country, Brazil, aiming to assess the conceptions of six groups of teachers (primary school teachers, biology teachers and Portuguese language teachers, and corresponding teachers-to-be) from São Paulo State about the topic evolution, in particular about their evolutionist and creationist conceptions. The research questions can be formulated as follows: Do the groups of Brazilian teachers have different conceptions about evolutionism and creationism? Are there differences when the conceptions from Brazilian teachers are compared to those of the BIOHEAD-CITIZEN project?

1.1 The Context of This Work

The study developed under the project BIOHEAD-CITIZEN is based mainly on the teaching of science, but also covers the area of social psychology in the context of social representations [9]. In the field for didactics of science, the term "conception" has better acceptance [10] than the term "representations" [11]. Duit [12] has produced and has been updating a list of scientific papers developed upon the conceptions of teachers and students.

The project BIOHEAD-CITIZEN assumes that the views of different actors of the education system emerge from the interaction of scientific knowledge (K), systems of values (V) and social practices (P) [13]. Although the concepts can be examined under another conceptual framework, this model KVP (Fig. 1) has been very useful in the analysis of important characteristics of knowledge that have been taught, once it enables to understand how worth a scientific presentation is when it is related to science and values or social practices, within epistemological scope. Knowledge (K) refers to information from the scientific community. The values (V) in this model are given in a large sense of the term, including opinions, beliefs and ideologies. For example, sexism, racism or xenophobia, are all considered, as well as the search for truth by means of science and "scientific ideologies" as defined by the epistemologist Canguilhem [14] to characterize trends in the biological sciences, such as reductionism the anatomization or the absolute genetic determinism. The social practices (P) range from the teaching practices inside the classroom until the social current conception which features not only the students' future carrier, but also influence the citizens to be formation.

The aim of the research project BIOHEAD-CITIZEN is to explore multiculturalism related to the teaching of controversial and important topics such as health education, sex education,
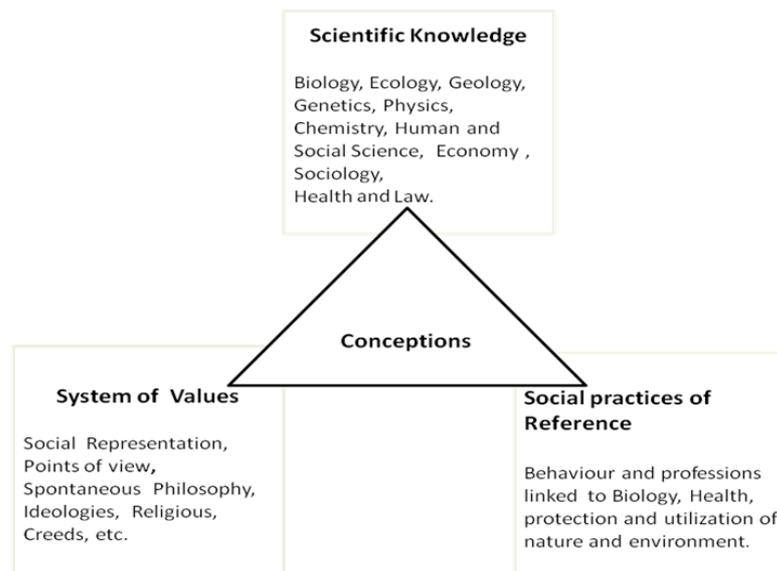

Fig. 1 **The KVP model. Conceptions in the light of scientific knowledge, system of values and social practices of Ref. [13].**

environmental education, and evolution (especially the sensitive issue of human origin) epigenesis associated with the socio-cultural determinism of human behaviour, and reductionism in the teaching of human genetics [3].

A priori it might be assumed that knowledge is universal, as reference having the same publications and thus all curricula and textbook contents would be the same in all countries. Similarly, all teachers' conceptions would be the same no matter what subject they were addressing. The development of this project BIOHEAD-CITIZEN shows that this idea is not correct, especially in these "alive issues" that often are articulated in social and scientific debates [15].

1.2 Evolutionism and Creationism

The history of the Earth and humanity can be explained in light of Creationism or Evolution. The first is based on the concept that a Creator (God) gave rise to the world with all living beings, as it is today. Based on the generations of the Bible, the Anglican Archbishop James Usher (1581-1656) proposed that the world would have been created on October 23 4004 BC at noon, e.g., around 6000 years [16]. The idea that all species have remained unchanged since the establishment was named fixism.

In contrast to fixist ideas, the Evolution Theory assumes all forms of life having undergone many changes throughout the Earth history, including those supposed extinctions which were held during all that time. It is based on evidence obtained through fossil records, analysis of anatomy and embryology, comparative biochemistry and geological and cosmological molecular studies [17].

From the use of radiometric dating methods, for example, it is estimated that the Earth was originated nearly 4.5 billion years ago and the emergence of life on the planet would have happened approximately 3.5 billion years ago [18]. Contrary to Creationist Theory, which places the individual on a different level from other living beings, the Theory of Evolution, based on

the proposal of the English naturalist Charles Robert Darwin (1809-1882), proposed that all living organisms descend from a common ancestor. Based on fossil evidence and molecular studies, "it is likely that the lineage of the human species arose between five and eight million years ago." [17].

Given the different views about the origin of Earth and humanity, the relationship between radical creationists and evolutionists are conflicting. The anti-evolutionists, i.e., radical supporters of creationism, refused to accept the theory of evolution. They claimed that this is just a "not proven theory" and that there was no consensus among scientists themselves about various aspects related to it. They quoted as an example the age of the universe, the Earth, as well as issues which have not been clarified yet in the evolution of species. In this regard, the geneticist Theodosius Dobzhansky, in his article of 1973 [19] entitled: "Nothing in biology makes sense except in the light of evolution", argued that there are many divergences among scientists, but those are issues that contribute to the development science and added: "Seen in the light of evolution, biology is, perhaps, intellectually the most satisfying and inspiring science. Without that light it becomes a pile of sundry facts some of them interesting or curious but making no meaningful picture as a whole".

The clash between creationists and evolutionists becomes more evident in discussions about the teaching of evolutionary theory in biology classes. A striking example, roughly, is the debate that occurs more vigorously in the United States. Actually, there is a social demand for the Theory of Evolution that is taught on an equal pattern with the Creationist Theory. Meadows, Doster and Jackson [1] commented on the discomfort that these issues can lead to teachers of biology: "Biology teachers face the demanding challenge of crafting a learning environment that mediates colliding agendas. They want students to deepen their understanding of biological evolution in order to become scientifically literate citizens. At the

same time, they also want to support, rather than undermine, the values of students, parents and communities whose worldviews can oppose the teaching of evolution. On private and often unspoken level, many biology teachers themselves must face their own unresolved conflicts between biological evolution and their personal worldviews".

In this regard, it is pertinent to ask: What are Brazilian teachers' conceptions about the origin of life and humankind? Are they either creationists or evolutionist? Or can they believe in both ideas concomitantly? Considering that the views of different actors (in this case teachers and teachers to be) emerge from the interaction of scientific knowledge (K), systems of values (V) and social practices (P), the KVP model [3, 13], the results of this study are discussed within this framework.

2. Material and Methods

The entire BIOHEAD-CITIZEN questionnaire containing 144 questions was applied, from September until December 2008, to six groups of S. Paulo countryside teachers and university students (teachers-to-be): 50 in service primary school teachers (In-P); 50 in service biology teachers (In-B); 50 in service Portuguese language teachers (In-L); 50 primary school teachers-to-be (Pre-P); 50 biology teachers-to-be (Pre-B); 50 Portuguese Language teachers-to-be (Pre-L). It is worthy to highlight that this is a convenience sample therefore it cannot be generalized to the total population of in-service and teachers-to-be in Brazil.

Following the guidelines of BIOHEAD-CITIZEN project, the teachers-to-be filled in the questionnaire at the university they were studying, while the teachers did it at the schools where they were teaching. They filled the questionnaire anonymously in the presence of the researcher, as explained in detail elsewhere [20].

The "evolution" questions used in this work are shown in Appendix 1. The multivariate analysis was used for the answers assessment, as this method has

become a standard in investigating complex data featuring the behaviour of many individuals, when many variables are used [21]. The principal component analysis (PCA, [21]) was also applied. To complement the initial PCA (which differentiated all the individuals), the between groups analysis [22] was carried out to show the differences among groups' conceptions (groups of teachers, level of training, religions, and faith). The Monte Carlo test was used to analyse the levels of significance differences between groups. The statistical analysis was performed by using the software package SPSS statistic for Windows, version 17.

3. Results and Discussions

3.1 Principal Components Analysis of all the Variables "Evolution"

The principal component analysis (PCA) summarizes a large number of questions, so as to identify a limited set of important conceptive guidelines, characterized by a coherent set of answers to certain questions. The most remarkable eingenvalues features the principal component 1 (first bar in Fig. 2), represented by the horizontal axis (C1) in Fig. 3. The second component, which corresponds to the vertical axis (C2) of Fig. 3, is rather weaker (Fig. 2), so that the first component is the one that expresses mostly the highest variance among respondents (27%).

The "Evolution" questions, or variables, that structure
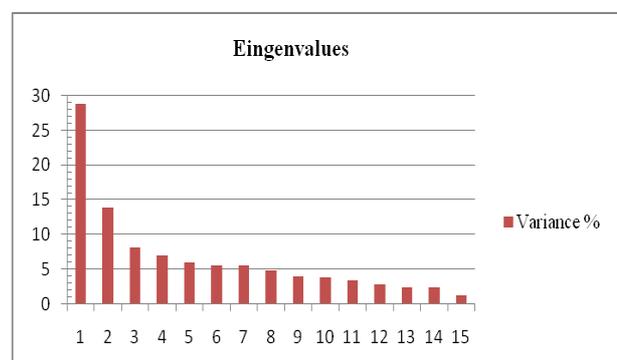
Fig. 2 Histogram of Eingenvalues, featuring the part of variance which realizes each component of PCA. The first two axes are the most important ones and represent the axes on the graph shown in Fig. 3.

the PCA components 1 and 2 are presented in Table 1 and are projected in Fig. 3.

Variables structuring axis 1 (horizontal) opposes the creationist views (left of Fig. 3) to the evolutionists (right of Fig. 3). These are conceptions associated to beliefs and values (V). The variables that define the second axis (vertical) are related to familiarity with biological sciences (the role of Intelligent design (B44), Viruses (B47) and the Surrounding environment (B45) on evolutionary processes). These are conceptions associated to scientific knowledge (K) about evolution.

Questions B45, B46 and B48 (Importance of the Surrounding environment, Transposons and God in the evolution of species) are involved in two axes, which shows an interaction KV between "Values" (axis 1) and "Scientific knowledge" (axis 2). Questions B45 and B46 almost overlap, pointing to the right and the top, which means that the evolutionary conceptions (far right) are more correlated with the importance given to Surrounding environment and Transposons (and therefore more positive about the axis 2) and vice versa. In contrast, the B48 variable points to the left, indicating that creationists emphasize the importance of God in the evolutionary process.

The importance of natural selection, indicated by the vector B43, on the right up side of Fig. 3, has a high weight on axis 1 but short weight in axis 2. This shows that natural selection is of upmost importance for

Table 1   Questions that contribute most to axis 1, their formulations in the questionnaire and its coordinates on the axes C1 and C2.

Variable/Question		C1	C2
B43	Indicate your evaluation of the importance of the following factors in species evolution (great importance; some importance; little importance; no importance at all).	0.755	0.177
B28	Which of the following four statements do you agree with most? (1) It is certain that the origin of the humankind results from evolutionary processes. (2) Human origin can be explained by evolutionary processes without considering the hypothesis that God created humankind. (3) Human origin can be explained by evolutionary processes that are governed by God. (4) It is certain that God created humankind	0.755	0.342
A64	Which of the following four statements do you agree with the most? (1) It is certain that the origin of life resulted from natural phenomena. (2) The origin of life may be explained by natural phenomena without considering the hypothesis that God created life. (3) The origin of life may be explained by natural phenomena that are governed by God. (4) It is certain that God created life.	0.746	0.405
B48	Indicate your evaluation of the importance of the following factors in species evolution. Importance of *God* in species evolution. *(great importance; some importance; little importance; no importance at all).*	0.613	0.489
B45	Indicate your evaluation of the importance of the following factors in species evolution. Importance of Surrounding environment in species evolution. *(great importance; some importance; little importance; no importance at all).*	0.601	0.515
B46	Indicate your evaluation of the importance of the following factors in species evolution. Importance of transposons (jumping genes) in species evolution. *(great importance; some importance; little importance; no importance at all).*	0.598	0.495

Table 2   Questions that contribute most to axis 2, their formulations in the questionnaire and its coordinates on the axes C1 and C2.

|	Variable/Question Indicate your evaluation of the importance of the following factors in species evolution *(great importance; some importance; little importance; no importance at all)*	C1	C2
B44	A program inside the organism (intelligent design)	0.360	0.653
B47	Viruses	0.370	0.571
B45	Surrounding environment	0.601	0.515
B46	Transposons (jumping genes)	0.598	0.495
B48	God	-0.613	0.489
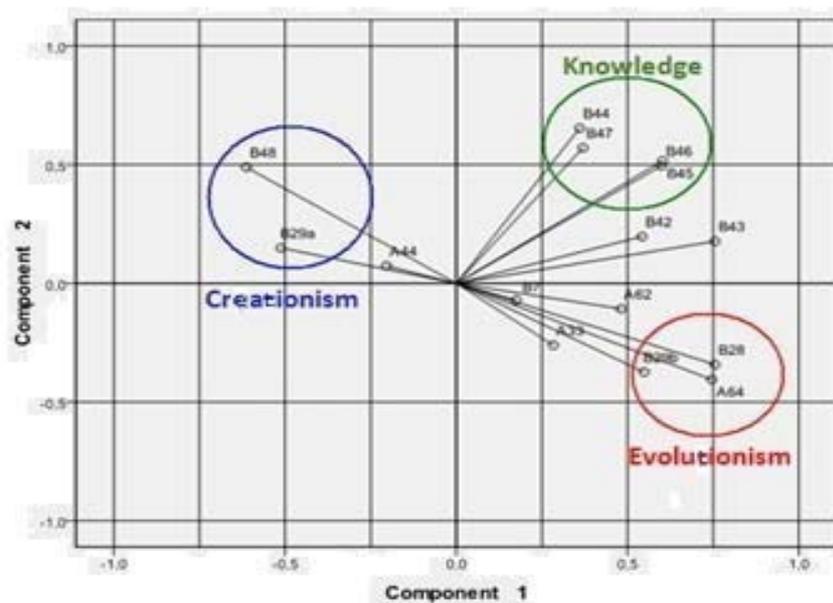
Fig. 3   Graphical representation of the PCA analysis on "Evolution" questions, allowing the analysis on the significance of the space defined by the two principal components 1 and 2, which are, respectively, the horizontal axis (abscissa) and vertical (ordinate). Each question represents a vector; the length of its projection on each of the two axes indicates its contribution to the definition of that axis. The circles that group the more structural issues of the axes were manually added to the graph.

evolutionists and that creationists don't see it relevant, maybe rejecting it as being associated to more materialistic philosophies, such as capitalism, or racism. In addition, the low relevance in the axis 2 may be related to those people (either creationists or evolutionists) who interpret the natural selection as scientific theory rather than an ideology, in a manner not conflicting with their moral values.

Results of the crosstabulation between B29a and B29b (Table 3) showed that out of the total sample (N = 282), 6% (18) accept neither the theory of evolution nor the creationism, while 46% (N = 132) cope well with both conceptions, suggesting that both views are not relevant to their system of values. About 20% (N = 57) of the respondents accept the theory of evolution, but refuse the theory of creationism. Finally, 27% (N = 75) accept the creationism, but do not accept the evolutionism, showing that the creationism is stronger in this sample.

3.2 Analyses between Classes (Groups of Teachers)

Fig. 4 shows the teachers' and teachers-to-be' groups distribution in function of the two principal

Table 3   Crosstabulation between questions B29a and B29b.

		Question B29b		Total
		Yes	No	
Question B29a	Yes	18	75	93
	No	57	132	189
Total		75	207	282

B29a-The theory of evolution contradicts my own beliefs: ☐ Yes ☐ No; B29b-Creationism (including the creation of human beings by God) contradicts my own beliefs: ☐Yes ☐ No.

components (C1 and C2). Both in-service and Biology teachers-to-be (In-B and Pre-B) and both in-service Language and Primary school teachers (In-L and In-P) teachers are clearly separated from the former groups. In between there are the Primary and Language teachers-to-be (Pre-P and Pre-L). These results indicate that the Biology education may be an important factor for developing scientific knowledge about Evolution.

When looking at the answers of different groups of teachers and teachers-to-be, it becomes clear that the majority of In-P and Pre-P as well as In-L and Pre-L have creationist conceptions. In contrast, less half of the In-B and pre-B has creationist conceptions (Figs. 5A, 5B and 5E). In agreement with our results, a recent
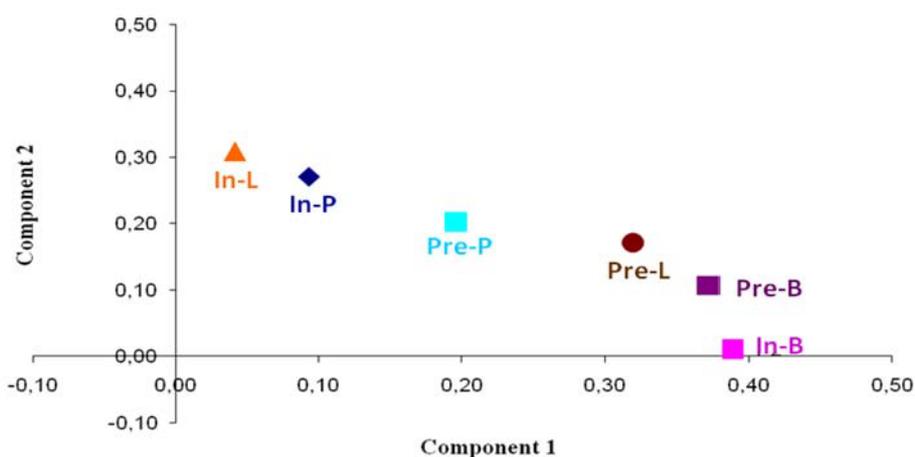
Fig. 4 Teachers' and teachers-to-be' groups distribution in function of the two principal components (C1 and C2).

survey in Brazil, published in April 2010 in the newspaper *Folha de São Paulo* [23], revealed that "the majority of Brazilians (59%) matches the acceptance of Darwinian process with faith in the conduct and supervision of God, located in a plane superior to nature".

The most teachers and teachers-to-be of all groups answered that the theory of evolution (Fig. 5C) does not contradict their own beliefs; similarly, the creationism does not contradict their own beliefs either (Fig. 5D).

Almost all In-B and pre-B teachers (above 90%) give great importance to the process of natural selection concerning the evolution of species while only 30% to 40% of In-P and Pre-P, give great importance to this process (Fig. 5F). The Portuguese language (In-L and Pre-L) teachers are in between those groups ranging from 50% to 70%, respectively.

These results agree with previous ones concerning 12 countries [4], as far as the biology teachers and biology teachers-to-be give more importance to the natural selection and the evolution process, however the total Brazilian sample shows a higher percentage of creationist conceptions.

4. Conclusions

Having in mind the KVP model [13] our results showed a strong influence ruled by religious values (V) concerning the origin of life and humankind and that this influence was lower in the biology teachers and teachers-to-be than in the other groups, indicating that knowledge (K) is an important factor for accepting the evolution theory and elapse the God influence in life creation. The variable social practices (P) were not focused in this study. Although in general our results were in agreement with previous studies carried out within the BIOHEAD-CITIZEN project [4, 8], the Brazilian biology teachers and teachers-to-be still showed stronger effect of religion than in other countries.

All the Brazilian respondents, who formed the groups of in-service teachers and teachers-to-be, understand the importance of the natural selection within the evolution but, on the other hand, almost half of them do not invalidate the hypothesis of one Creator who rules that process. This reinforces the studies by Quessada et al. [8], claiming the evolution and creation are not necessarily opposites. Furthermore this is in agreement with Gould [24], who argued that religion and science are "non-overlapping magisteria", having separate domains of teaching authority.

What are the reasons for the respondents accept both creationist and evolutionist ideas apparently not conflicting between them? Does it constitute an obstacle for the Evolution teaching?

One possible answer to the first question can be taken from the conceptual profile change model [25] which explains that persons do not need to abandon or
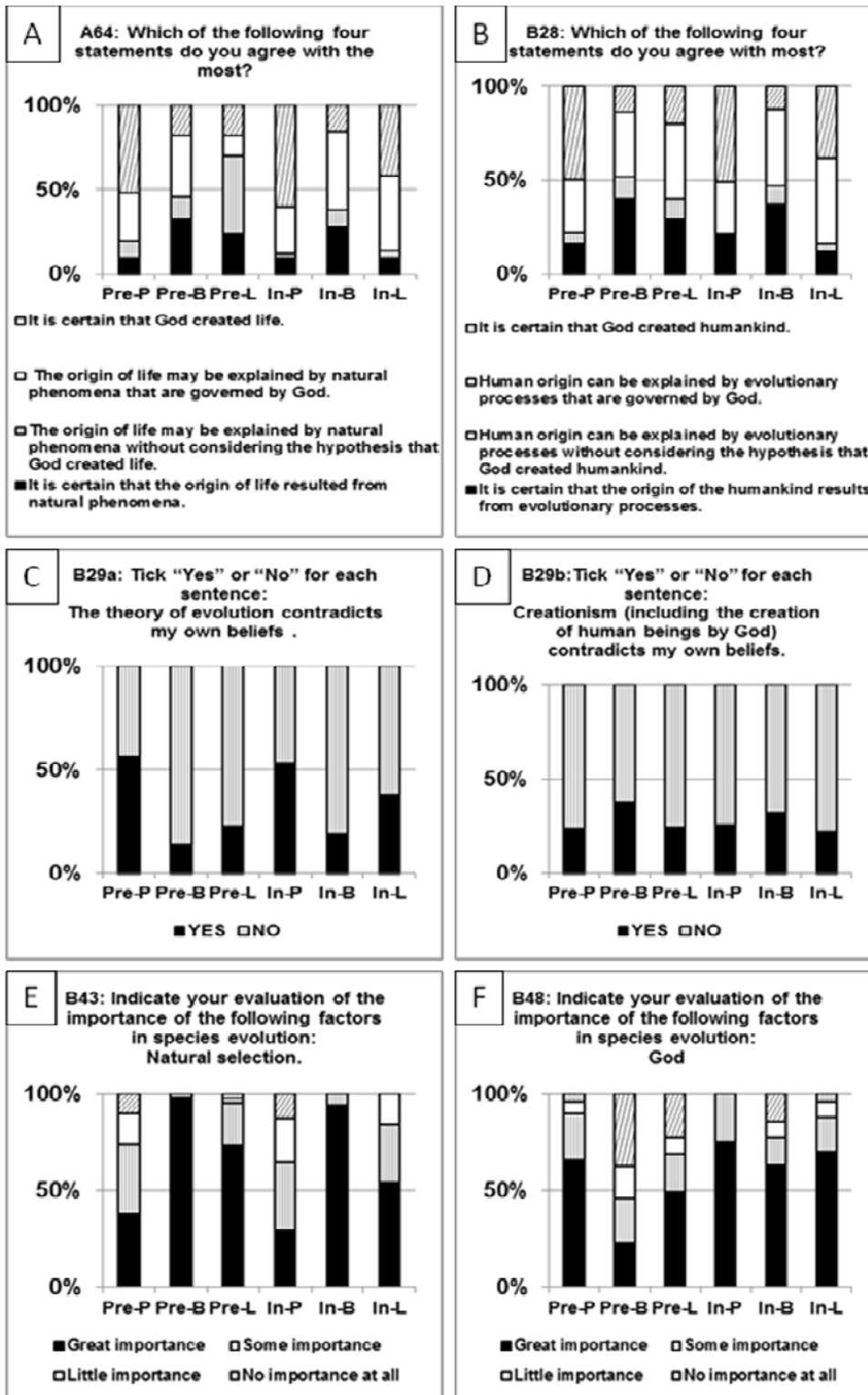
Fig. 5   Answers of groups of teachers and teachers-to-be questions A64, B28, B29a, B29b, B43 and B48, respectively, A to F.

to replace their previous/alternative conceptions to understand the scientific concept, i.e., it is possible for the coexistence in a single person of two or more

meanings for the same word or concept, which are evoked in the suitable context. In this sense, it is plausible to admit that the biology teachers and

teachers-to-be of this study understand the evolution ideas without dismissing their own worldviews. As referred by El-Hani & Bizzo [26]: "The teaching of science should, above all, show students how a set of problems is solved by the scientific perspective, broadening the spectrum of possibilities available to them. Now, the question of whether or not students believe in the scientific conceptions, rather only understand them, can be properly understood as a problem of an intimate nature of the student being examined by him in the context of his worldview, the light of ideas that have strength and power to".

The acceptance or refusal of the evolutionist ideas is a teacher's personal matter as well as it is for students. One must highlight that inside the classroom the role of the teacher is to arise students' motivation to understand the scientific concepts and to explain that within their own individual contexts, speeches of scientific conceptions and alternatives has its validity and its range [26]. It does not mean obviously that both values and creeds should be taught with the same equal pattern inside the classroom. However, teachers should promote the explicating and discussion of values and creeds so that the youngsters acquire a critical attitude about life and, in this way, they can corroborate to a better citizenship.

Acknowledgments

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Appendix 1

"Evolution" questions.

A33. The emergence of the human species (*Homo sapiens*) was just as improbable as the emergence of any other species.					
I agree					I don't agree

A44. The emergence of the human species (*Homo sapiens*) was the aim of the evolution of living species.					
I agree					I don't agree

A62. In the list below, tick the THREE expressions that you think are the most strongly associated with the origins of humankind.
☐ Adam and Eve ☐ Australopithecus ☐ Creation ☐God ☐ Natural Selection

A64. Which of the following four statements do you agree with the most? (tick only <u>ONE</u> answer)
☐ It is certain that the origin of life resulted from natural phenomena.
☐ The origin of life may be explained by natural phenomena without considering the hypothesis that God created life.
☐ The origin of life may be explained by natural phenomena that are governed by God.
☐ It is certain that God created life.

B7. The Chimpanzee should be included in the genus *Homo*, notably because 98.5% of this DNA is identical to that of *Homo sapiens*.					
I agree					I don't agree

B28. Which of the following four statements do you agree with most? Select <u>ONLY</u> one sentence:
☐ It is certain that the origin of the humankind results from evolutionary processes.
☐ Human origin can be explained by evolutionary processes without considering the hypothesis that God created humankind.
☐ Human origin can be explained by evolutionary processes that are governed by God.
☐ It is certain that God created humankind.

B29. Tick "Yes" or "No" for each sentence:
B29a-The theory of evolution contradicts my own beliefs
☐ Yes ☐ No
B29b-Creationism (including the creation of human beings by God) contradicts my own beliefs
☐Yes ☐ No

Indicate your evaluation of the importance of the following factors in species evolution. (tick only <u>ONE</u> box for each line):

		Great importance	Some importance	Little importance	No importance at all
B42	Chance				
B43	Natural selection				
B44	A program inside the organism (intelligent design)				
B45	Surrounding environment				
B46	Transposons (jumping genes)				
B47	Viruses				
B48	God				