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ANALYSIS OF PRE-SERVICE AND IN-SERVICE VIEWS OF EVOLUTION OF SERBIAN TEACHERS

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Abstract – We analysed the potential differences between the conceptions of Serbian pre-service and in-service teachers using controlled parameters such as acceptance of the evolution theory. Our sample includes Primary School teachers as well as Secondary School teachers of Biology and of Language. We show that the ideas of pre-service (PreB) and in-service biology teachers (InB) are more evolutionary than those of their colleagues. In contrast, most creationist responses came from the groups of pre-service language (PreL) and pre-service primary teachers (PreP). The agnostic teachers are more evolutionist than other teachers. The more a teacher believes in God and practices religion, the more creationist he or she is, but a great number of teachers who believe in God are evolutionist or simultaneously evolutionist and creationist. There is a positive correlation between evolutionist answers and the attitude that „Science and religion should be separated“, and „religion and politics should be separated“.

Keywords: pre-service teachers, in-service teachers, teachers' conceptions, evolution, creationism

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INTRODUCTION

Evolution is a central theory in the field of biology. Today, nothing in biology can be thought about without an evolutionary perspective. Nonetheless, biological evolution is one of the most misconceived and widely debated scientific phenomena (Alters and Alters, 2001; Miller, 1999). Although there is increasing diversity of evidence that supports it, the evolution theory is also one of the least understood and least accepted theories of modern science among the general public (Annaç and Bahçekapili, 2012).

There are many studies about teachers' attitudes and their understanding of biological evolution in

various international settings. Caldeira et al. (2010) indicate that the assessment of teachers' conceptions about evolution is important in understanding how they cope with issues related to the creationism versus evolution conflict in the classroom. American biology teachers think it is crucial that students learn biological evolution without questioning their personal and community values or world vision, which might be in opposition to evolutionary theory (Meadows et al., 2000). A study among Indiana public school teachers found positive correlation between teachers' acceptance of evolution and their exposure to biology, evolution, and the nature of science issues (Ruthledge and Mitchell, 2002). The study points to the importance of preparation by biology teachers of

programmes intended to develop a comprehensive understanding of evolution and the nature of science in their students.

A study of Canadian pre-service elementary teachers showed that biological evolution was not appropriately covered in their previous formal education (Asghar et al., 2007). This study supports the need for appropriate pedagogic training of future elementary teachers to be professionally prepared to critically reflect on, and deal with, any challenges and pressures regarding the teaching of evolution in elementary schools (Asghar et al., 2007).

Research about introducing pre-service teachers to issues associated with evolution and creationism has, via mock trial, shown a slight increase in understanding of evolutionary principles, decreased acceptance of a literal interpretation of the Biblical creation story, and increased acceptance of the accuracy of evolutionary theory (Helgeson et al., 2002).

A study in Papua New Guinea among primary and secondary pre-service science teachers and their attitudes toward evolution education revealed that primary trainee teachers demonstrated a poor understanding of and negative attitudes towards teaching evolution, while secondary science teacher trainees appeared to understand the value of evolution education (Vlaardingerbroek and Roederer, 1997).

Teaching evolution may be related to the religious beliefs of teachers. Trani (2004) found an inverse relationship between teachers' strong "religious convictions" and their decisions about teaching evolution in the classroom.

Based on the literature concerning evolution education, four factors that are potentially related to acceptance of the evolutionary theory (Deniz et al., 2008; Athanasiou and Papadopoulou, 2011) can be identified. These include students': (i) reasoning level (Lawson and Thompson, 1988; Lawson and Weser, 1990; Lawson and Worsnop, 1992, Sinatra et al., 2003); (ii) perceptions of the impact of the evolution-

ary theory (Brem et al., 2003); (iii) epistemological beliefs (Sinatra et al., 2003); and (iv) thinking dispositions (Sinatra et al., 2003).

While there are recent international works reporting on teachers' understanding of evolution (Clément, 2013, 2014; Clément and Quessada, 2009, 2013, 2014; Clément et al. 2013), very little is known about the acceptance by Serbian pre-service and in-service teachers of the evolution theory and controlled parameters such as religion, values and political views. In the present work, teachers' conceptions are analyzed in terms of possible interactions among the three poles (Knowledge, Values and Practices), as proposed by the KVP model (Clément 1998, 2004, 2006). In this specific context of teachers' conceptions, the scientific knowledge (K) refers to the publications coming from the scientific community; the social practices (P) are the school teaching practices, the textbooks, authors and publishers referenced, and the way of using textbooks in the teaching process; the values (V) are defined in a large sense, sustaining teachers' opinions, beliefs and ideologies (Clément and Carvalho, 2007).

In this paper we intend to analyze conceptions of Serbian pre-service and in-service teachers about evolution according to the Clément (1998, 2004, 2006) KVP model. The work followed the criteria established in the European FP6-STREP project Biohead-Citizen (Carvalho et al., 2004, 2008). For this purpose and to analyze differences in teachers' conceptions about evolution with regard to several influential parameters: religion, political view, values and teachers' academic degrees, we applied the Serbian version of the Biohead-Citizen questionnaire to pre-teachers and in-service teachers from Serbia.

MATERIALS AND METHODS

The total sample for this investigation was composed of 314 teachers from Serbia, including pre-service and in-service teachers. Following the Biohead-Citizen criteria of a minimum of 50 participants per group, the subsamples were: pre-service primary

school teachers, PreP (53); in-service primary school teachers, InP (51); pre-service biology teachers, PreB (55); in-service biology teachers, InB (52); pre-service language teachers, PreL (52); and in-service language teachers, InL (51).

The original English questionnaire was built by the Biohead-Citizen project consortium, tested in pilot tests, validated and finally improved to obtain the final version (Clément and Carvalho, 2007; Munoz et al., 2009). This English questionnaire was then translated into each language of the consortium, according to specific rules for controlled translation and validation. The Serbian version of the questionnaire used in this investigation followed the same rules.

For this work, fifteen questions concerning evolution were used (Appendix): A33, A44, A62, A64, B7, B28, B29a, B29b, B42, B43, B44, B45, B46, B47, B48; three questions about religion: P12a, P12b, P13; thirteen questions about values related to the equality among genders or human groups: A2, A9, A14, A15, A21, A25, A30, A35, A36, A38, A41, A46, A52 and twelve questions about more social or political views: A20, A26, A34, A37, A42, A48, A51, A56a, A56b, P9, P10, P11 (Appendix).

Since it has become a standard method to investigate complex data involving many individuals and many variables, multivariate analysis was applied to analyse data (Lebart, et al., 1984). The variables are the questions for which we gathered answers. To analyse the evolution education answers, the principal component analysis (PCA, Lebart et al., 1995) was used. Between-group analysis (Dolédec and Chessel, 1987) was carried out to identify differences between groups: the six groups of pre-service and in-service teachers, their level of training, their religion and their socio-political views. Each between-groups analysis was completed by a randomisation test (Monte Carlo) to analyse the levels of the significance of the differences between groups. When two variables can be in interaction, the effect of one was suppressed by orthogonal PCAVi to analyse the effect of the second variable independently (Munoz et al., 2009, Castéra and Clément, 2014).

RESULTS AND DISCUSSION

Taking into account the views of the theory of evolution and origins of the world and human beings (Evolution - one of the areas for research in the European FP6 Biohead-Citizen research project) in Serbia, within the framework of six groups-categories of teachers (InB, InL, InP, PreB, PreL, PreP), Fig. 1 shows the results of a between-class analysis differentiating the six groups of teachers. The Monte Carlo test shows that the difference among the six groups is very significant ($p > 0.001$). Each point in Fig. 1b corresponds to a teacher, and each ellipse surrounds 2/3 of the teachers from the same group (identified by a number in the centre of the ellipse). The first component of this multivariate analysis, corresponding to the horizontal axis of Fig. 1b, expresses 75% of the total variance, while the second component (vertical axis) expresses only 9% and consequently is not taken into consideration. Evolutionist answers are presented on the left side of the horizontal axis and creationist answers on the right side (Fig. 1a). We can conclude that pre-service (PreB) and in-service biology teachers (InB) are more evolutionist than their colleagues. In contrast, most creationist responses came from the groups of pre-service language (PreL) and pre-service primary teachers (PreP). Between these two opposite poles are located the other in-service teachers (InL and InP). Corresponding to the professional qualifications and level of education, for biology teachers and other groups of teachers this is understandable. The questions which most differentiate the six groups are A64, B28, B48 and A62, at the right of the horizontal axis in Fig. 1a. Figures 2 to 4 show the percentage of answers for these questions. Concerning the origin of life (question A64) and the origin of humankind (question B28), about 20% of PreL and PreP teachers ticked the radical creationist item, while less than 10% of their colleagues ticked this item; and more than 80% of biology teachers (InB and PreB) ticked the evolutionist items (1 or 2).

Fig. 4 shows that a relatively large proportion of teachers ticked 'great' for the item 'some importance of God in species evolution', while only a small part of them ticked a radical creationist item in questions

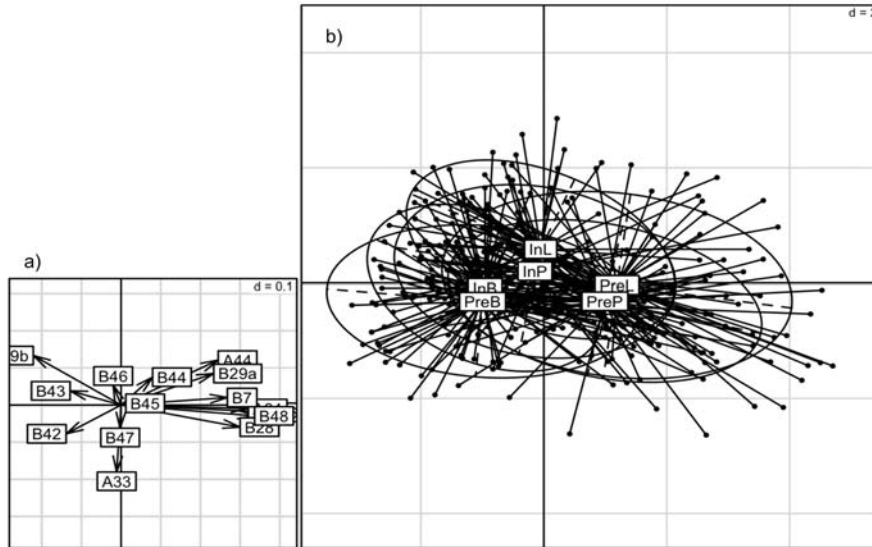


Fig. 1. Between-class analysis to differentiate the six groups of teachers.

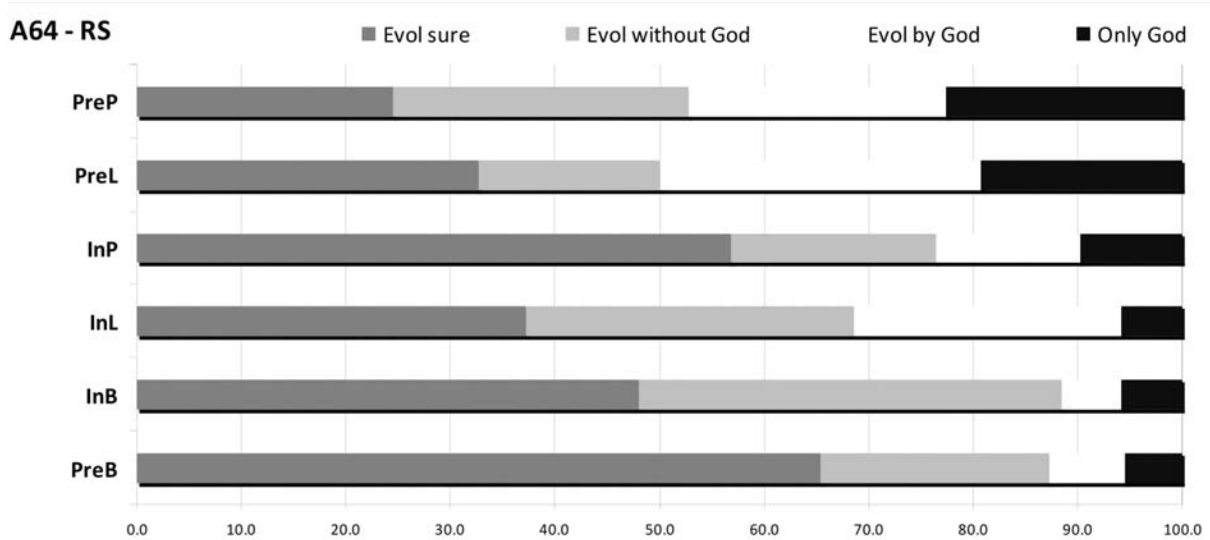


Fig. 2. Teachers' answers to question A64, grouped by group of teachers.

A64. Which of the following four statements do you agree with the most? (tick only ONE answer)

- (grey) It is certain that the origin of life resulted from natural phenomena.
- (grey) The origin of life may be explained by natural phenomena without considering the hypothesis that God created life.
- (white) The origin of life may be explained by natural phenomena that are governed by God.
- (black) It is certain that God created life.

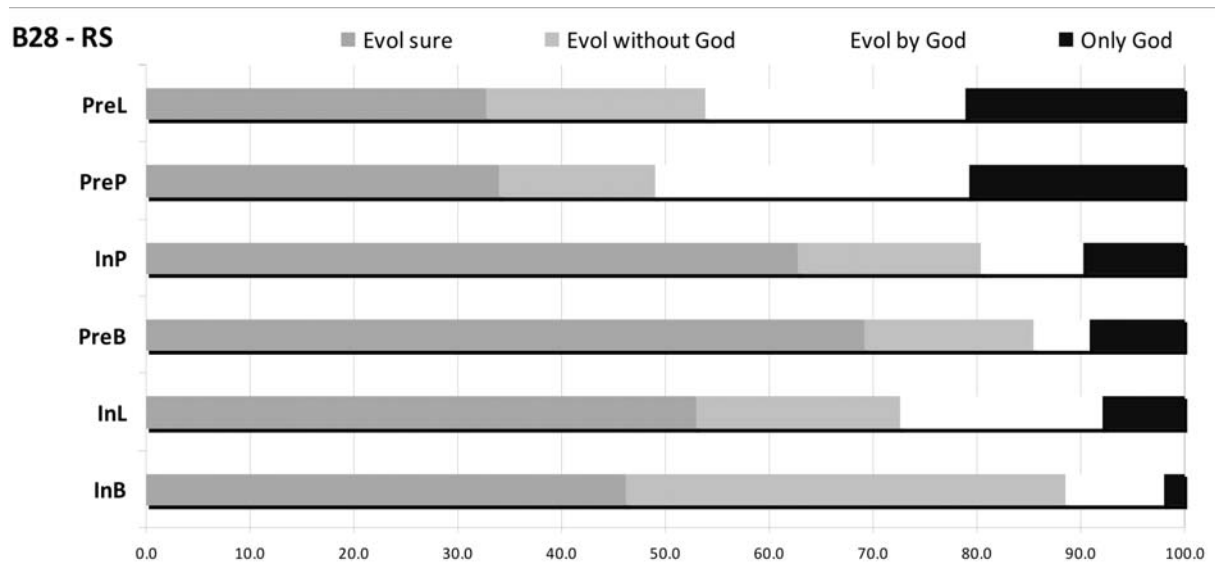


Fig. 3. Teachers' answers to question B28, grouped by group of teachers.

B28. Which of the following four statements do you agree with most? Select ONLY one sentence:

- (grey) It is certain that the origin of humankind results from evolutionary processes.
- (grey) Human origin can be explained by evolutionary processes without considering the hypothesis that God created humankind.
- (white) Human origin can be explained by evolutionary processes that are governed by God.
- (black) It is certain that God created humankind

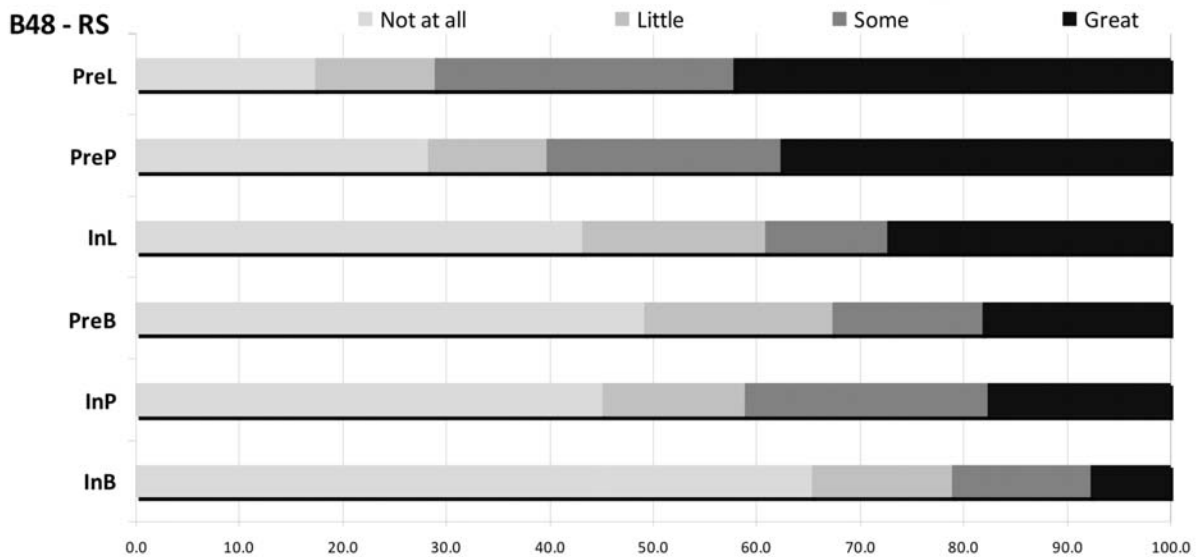


Fig 4. Teachers' answers to question B48, grouped by groups of teachers.

Indicate your evaluation of the importance of God in species evolution : from "great importance (in black) to "no importance at all" (pale grey)

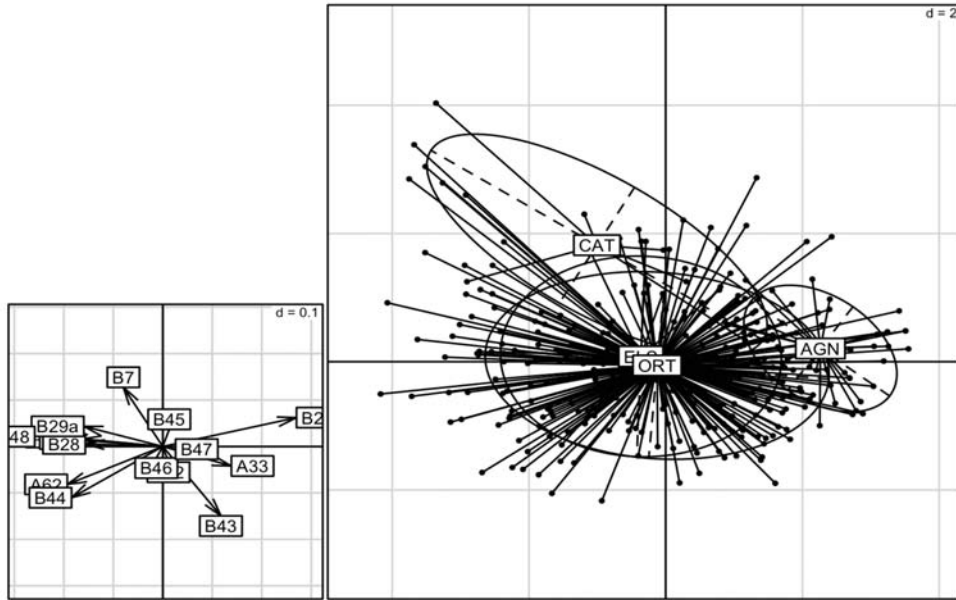


Fig. 5. Between-class analysis to differentiate the religion groups: AGN=Agnostic or Atheist; ORT=Orthodox; CAT=Catholic); ELS=Other religion of no answer.

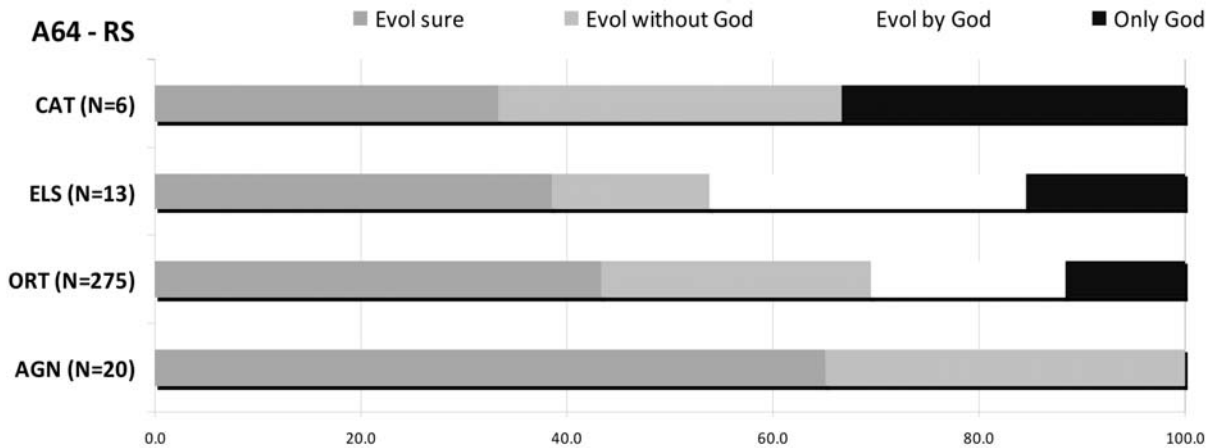


Fig. 6. Teachers' answers, grouped by religion, to question A64

A64 and B28. For instance, 40% of PreL and PreP teachers ticked 'great importance of God' (Fig. 4) while only 20 % ticked the radical creationist item in Fig. 2 and 3. A significant number of teachers believing in God and in the importance of God in species evolution are not radical creationist, but are at once both evolutionist and creationist (item 3 of questions A64 and B28) or even clearly evolutionist (items 1 or 2 of these questions).

Fig. 5 shows the results of a between-class analysis differentiating the teachers depending on their religion. The difference is significant (Monte Carlo test) mainly because the agnostic group of teachers is more evolutionist than the other groups. In the largest group of Orthodox Christian teachers, there is a wide range of answers (from evolutionist to creationist). Fig. 6 illustrates the differences among religions for answering question A64: not one of the 20 agnos-



Fig. 7. Co-inertia analysis, showing the correlation between a PCA built from Evolution variables (upper graph) and a PCA built from political, social and religious opinions of teachers (lower graph). Answers are represented by vectors, where the arrow position indicates the contribution of each question to the horizontal axis (75% of the total variance), by vector projection on this axis.

tic or atheist teachers ticked items 3 or 4 (creationist and evolutionist, or radical creationist).

In Fig. 4, the Co-inertia analysis between a PCA from „socio-political and religious” variables and a PCA from evolution variables is presented. It shows that the more a teacher believes in God (question 12a) and practices religion (question P12b), the more creationist he or she is. There is also a positive correlation between evolutionist answers and the atti-

tude that „Science and religion should be separated” (question A51), and „Religion and politics should be separated” (question A37).

The other between-class analyses are not significant: no significant differences related to parameters such as gender, age, level of teachers’ instruction, ... , nor is there correlation between the PCA from evolution variables and the PCA from the “values variables” (gender equality, ...).

Results of some studies can be compared, as well as results from other countries involved in the Biohead-Citizen project (e.g. Brazil). Results from Brazilian pre-service and in-service teachers are very similar to our results. The majority of creationist conceptions came from In-P, Pre-P, In-L and Pre-L teachers. These results indicate that biology education may be an important factor in developing scientific knowledge about evolution (Caldeira et al., 2010). However, relative to the other countries Brazilian Pre-B and In-B teachers still showed a stronger effect of religion, but this effect is less strong for biology teachers than for the other groups, indicating that knowledge (K, with the KVP model in mind) is an important factor in evolution acceptance (Quessada et al., 2007; Clément and Quessada, 2013, 2014). Nevertheless, these works found a significant difference related to the teachers' level of instruction (teachers with more university study are more evolutionist), a difference not found in Serbia.

In Serbia, most teachers are Orthodox. Compared to Orthodox teachers in other countries included in the Biohead-Citizen research (Clément and Quessada 2014), Serbian Orthodox teachers are clearly more evolutionist: that illustrates an effect of the country already demonstrated when comparing other countries (Clément and Quessada 2009, 2013, 2014).

The findings from the study among Canadian pre-service elementary teachers suggest that they seemed to lack an understanding of evolution concepts. This study gave supporting evidence that students' religious beliefs influence their scientific understanding of evolution. The appropriate pedagogic training of future elementary teachers is very important in order to prepare them professionally to critically reflect on, and deal with, any challenges and pressures regarding the teaching of evolution in elementary schools (Asghar et al., 2007).

Based on self-reported strength of religious beliefs, Lawson and Worsnop (1992) reported that religious commitment was negatively correlated with acceptance of evolutionary theory.

Various studies of evolution education conducted in the last decade suggest that acceptance of the theory of evolution is related to a number of different factors. One such study is a Greek study of Greek university students who were training to be teachers. That study examined the acceptance of the evolution theory and the relationship between that acceptance and the parents' education level, thinking dispositions and frequency of religious practice as independent variables. Pre-service teachers' moderate acceptance of the evolution theory is positively correlated with the frequency of religious practice and thinking dispositions. The results of this study also indicate the differences that exist between societies and how socio-cultural factors such as the nature of religion influence acceptance of evolution and have an influence on evolution education (Athanasidou and Papadopoulou, 2011).

The results of study among Turkish pre-service biology teachers have shown that there was no significant positive correlation between epistemological beliefs and acceptance of evolution. Thinking dispositions of pre-service biology teachers, their understanding of evolutionary theory, and their parents' educational level are positively correlated with acceptance of evolutionary theory (Deniz et al., 2008).

Considering the relation between evolutionist/creationist views and groups of teachers from Serbia, we can conclude that evolutionist responses dominate in Pre-B and In-B groups (which is consistent with their education), while creationist responses dominate in PreP and PreL groups. Accordingly, the greatest number of evolutionary responses to the questions concerning the origin of life and God as a factor in evolution are given by teachers from In-B and Pre-B groups.

The effect of religion suggests that in Serbia the largest numbers of creationist views could be in the population of Catholic teachers (Fig. 5 and 6), but there are only 6 Catholic teachers in our sample, and thus this difference is not significant. Agnostic teachers have the dominant number of evolutionist answers. The widest range of answers (from evolu-

tionist to creationist) is in the largest group of Orthodox Christian teachers.

The analysis of “socio-political and religious variables” and evolution variables indicates that the more a teacher believes in God and practises religion, the more he or she is creationist, and that a positive relation exists between advanced political views („science and religion should be separated“, „religion and politics should be separated“) and evolutionist concepts.

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Conflict of interest disclosure

All affiliations are listed on the title page of the paper. All funding sources for this study are listed in the acknowledgement section of the paper. The contents of this manuscript have not been copyrighted or published previously and are not now under consideration for publication elsewhere. All authors of this paper have read and approved the final version submitted. There is no conflict of interest, including any financial, personal or other relationships with other people or organizations.

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Appendix (Questions used in this work)

QUESTIONNAIRE 'A'

Indicate to what point you agree with the following statements by ticking only one box between "I agree" and "I don't agree" for **EACH** of the following statements:

A2.	In a modern society, men and women should have equal rights.	I agree						I don't agree
A9.	Women are less intelligent than men are because their brains are smaller than men's brains are.	I agree						I don't agree
A14.	Thanks to their physical features, men perform better in athletics than women do.	I agree						I don't agree
A15.	A priority of the government must be to guarantee resources for health protection of the poor.	I agree						I don't agree
A20.	My government should compel all immigrants to learn to speak, to read and to write in (my state language).	I agree						I don't agree
A21.	Biologically, women can be as intelligent as men.	I agree						I don't agree
A25.	It is for biological reasons that women cannot hold positions of as high responsibility as men can.	I agree						I don't agree
A26.	There are too many foreigners in my country: the government should limit immigration.	I agree						I don't agree

A30.	It is important that there are as many women as men in parliaments.	I agree						I don't agree
A33.	The emergence of the human species (<i>Homo sapiens</i>) was just as improbable as the emergence of any other species.	I agree						I don't agree
A34.	The government must make laws favouring the creation of firms to stimulate our economy.	I agree						I don't agree
A35.	Ethnic groups are genetically different and that is why some are superior to others.	I agree						I don't agree
A36.	Men might be more able to think more logically than women, because men might have different brain bilateral symmetry.	I agree						I don't agree
A37.	Religion and politics should be separated.	I agree						I don't agree
A38.	It is for biological reasons that women more often than men take care of housekeeping.	I agree						I don't agree
A41.	Homosexual couples should have the same rights as heterosexual couples.	I agree						I don't agree
A42.	Only a strong central power can put some order in my country.	I agree						I don't agree
A44.	The emergence of the human species (<i>Homo sapiens</i>) was the aim of the evolution of living species.	I agree						I don't agree
A46.	Biologically, men cannot be as sensitive and emotional as women.	I agree						I don't agree
A48.	Direct democracy (without government involvement) is the ideal solution to managing our society.	I agree						I don't agree
A51.	Science and religion should be separated.	I agree						I don't agree
A52.	It is acceptable that poor people not have access to the same health care quality as rich people.	I agree						I don't agree

A56. There is a decision-making process in the implementation of science applications related to environment and biotechnology. Indicate, in each line, your degree of confidence in different actors to make such decisions (tick only ONE case for each line):

Scientists					Members of Parliament
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Science experts of this specific field					Science experts of diverse fields including ethics
All the citizens (referendum)					Elected persons representing citizens at the national, regional or local levels

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 Evolution God Natural selection

A64. Which of the following four statements do you agree with the most? (tick only ONE 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.

QUESTIONNAIRE 'B'

Indicate to what point you agree with the following statements by ticking only ONE box between “I agree” and “I don’t agree” for EACH of the following statements:

B7.	The Chimpanzee should be included in the genus <i>Homo</i> , notably because 98.5% of its DNA is identical to that of <i>Homo sapiens</i> .	I agree					I don't agree
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B28. Which of the following four statements do you agree with most? Select ONLY one sentence:

- It is certain that the origin of 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:

- The theory of evolution contradicts my own beliefs Yes No
- 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 ONE 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				

QUESTIONNAIRE 'P'

Which institution do you trust more: Public or Private? (Tick **ONE** box in EACH line)

P9.	Public schools	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Private schools
P10.	Public health services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Private health services
P11.	Public pension	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Private pension

P12. (Tick one box in **EACH** line):

I believe in God	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I don't believe in God
I practise religion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I do not practise religion

P13. Are you? (tick only **ONE** box):

Agnostic/Atheist

Christian: Catholic Protestant Orthodox Other (specify): _____

Muslim: Sunnite Shiite Druze Other (specify): _____

Jewish

Other religion/belief (specify): _____

I don't want to answer