Study on the opinion of university students about the themes of the origin of Universe and evolution of life

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Abstract: This paper reports the results of a questionnaire administered to university students, about several questions involving the origin of the Universe and life and biological evolution, as well as questions related to more common scientific themes. As few as between 2.4% (philosophy students) and 14% (geography students) did not accept the theory of evolution, because they believed in creation as described in the Bible. However, between 41.5% (philosophy students) and 71.3% (biology students) did not see any conflict between religion and evolution. About 80% of the students believed that the relationship between lung cancer and smoking is well established by science, but this number falls to 65% for biological evolution and 28.9% for the big bang theory. It should be pointed out that for 24.5% and 7.4% of the students the big bang theory and biological evolution, respectively, are poorly established by science. The students who self-reported being Christian but not Roman Catholic are more conservative in the acceptance of biological evolution and the old age of Earth and the Universe than are other groups of students. Other factors, such as family income and the level of education of parents, appear to influence the students' acceptance of themes related to the origin of the Universe and biological evolution.

Introduction

Evolution is a complex theory, and thus, teaching biological evolution as well as the origin of life demands from teachers a solid background in several fields, such as genetics, chemistry, geology, palaeontology, etc. Besides the complexity of the theme, teachers also have to work with several concepts that are not part of the daily life of students. In a study carried out with Brazilian secondary teachers, about the teaching of evolutionary biology, 60% of those interviewed admitted some difficulties, such as the lack of preparation of the teachers, lack of didactic material and lack of time for this material in the curriculum (Tidon & Lewontin 2004). These authors also reported that 62% of the teachers considered that their students were immature and/or did not have a sufficient theoretical basis for understanding evolutionary biology. Besides these kinds of problems, Bloom & Weisberg (2007) also reported that adults and children do not readily accept scientific information that goes against their common sense, and this disbelief is more common in those societies where scientific theories are not well understood. In Western society, the general view of the theory of evolution is very different from the view of some conservative Christian groups, and according to Scott (1997) there is a long history of rejection of the evolution theory in the U.S.

The groups that do not accept evolution theory include particularly the advocates of intelligent design (ID). In addition, this latter group declares themselves as a scientific movement, not a religious one, whose main goal is to offer an alternative view of the origin and evolution of life. Indeed, this group is an offshoot of an old antievolutionist movement known as creation science (Scott & Matzke 2007; Forrest 2008). In the early 1980s, ID was planned as a new strategy to overcome the prohibition of the teaching of creation science in public schools in the U.S. (Pennock 2003). According to Apple (2003, 2008), the creationist movement was less successful than the Afro-American movement, where they used the same approach of cultural marginalization. For Moore & Miksch (2003), the success of American creationists could be due to the following facts: teachers are not well trained for teaching evolution, since many of them do not understand the meaning of the scientific theory or even do not understand how the science is done; many teachers are not familiar with the legal issues of teaching creationism in public schools,

which makes them vulnerable to the pressure of parents, students, the principal, etc. Finally, we also should take into account the religious beliefs of many teachers, making them creationist minded.

It should be pointed out that the main achievement of American creationists is not what they have accomplished in the U.S., but what they have done outside the country, meaning that they have spread their beliefs to several other countries, including Brazil, thereby influencing them. A study of 34 countries was carried out by Miller *et al.* (2006), showing that in countries such as Iceland, Denmark, Sweden and France, more than 80 % of adults accept the evolution theory as true and that in Japan this number is about 78 %. On the other hand, in countries such as Turkey, Bulgaria, Greece, Romania, Austria, Poland, Switzerland and the U.S., among others, more than 40 % of adults believe that evolution theory is wrong or that they are not sure about its validity. In Brazil, unfortunately, this may be more pronounced; a study conducted in January 2005 with 2002 people over 16 years age, published in a nationally circulated magazine (Brum 2005), showed that 33 % of Brazilians believe that man was created by God about 10 000 years ago and that 54 % believe that man evolved over millions of years ago, but through a process under God's supervision. The situation gets worse, as 89 % of the interviewees agreed that creationism should be taught in schools and that 75 % believed that evolution should be replaced by creationism.

Unlike the U.S., the main religion in Brazil is Roman Catholic. According to the database of the Brazilian Institute of Geography and Statistic (IBGE 2008), in 2000 the major religious group in Brazil was Roman Catholic with 73.6 % of the Brazilian population, followed by evangelists with 15.4 %. The evangelist group has been increasing in number in recent decades, since 1940 when they comprised 2.6 % of the Brazilian population. According to Pennock (2003), the Roman Catholic Church, as well as most Protestant groups, does not see a conflict between biological evolution and Christian faith; in general, these followers argue that biological evolution was the way that God chose for the creation of the biological world. Thus, most creationist groups arose from fundamentalist sects or evangelists who usually have a more literal view or more conservative interpretation of some biblical texts.

Although the Brazilian creationist movement is not as strong as the American one, it should not be considered insignificant. According to Brum (2005), the first Brazilian creationist society was founded in Brasília – DF in 1972, and it was named the Brazilian Creationist Society (Sociedade Criacionista Brasileira (SCB)). In 1979, the Brazilian Association of Research of Creation (Associação Brasileira de Pesquisa da Criação (ACBP)) was founded in Belo Horizonte – MG, and more recently in Campinas – SP, the Brazilian Center for Intelligent Design (Núcleo Brasileiro de Design Inteligente) was founded. Some of these societies, as well as some universities usually linked to religious groups, have been promoting creationist ideas in different ways, such as holding creationism meetings, promoting creationist books and developing internet sites. All of these efforts have a simple objective, that is, to promote creationist ideas for the public in general and to fight against specialists at all levels of Brazilian society. As a consequence of all these actions, they expect to evoke in the general public a feeling that creationism deserves the same treatment as evolution, even in the public school system.

We do not have information about the level of acceptance/ rejection of the evolution theory among students who have chosen to pursue an associate's degree. Since these students will be the future teachers in the Brazilian teaching system, it would be interesting to know what they think about biological evolution and how we can help them teach this subject in high school. In the present paper, we describe the results of a survey containing several questions involving the origin of the Universe and life and biological evolution, as well as questions related to more common scientific themes. The questionnaire was administered in the years 2006 and 2007 in the following curricula (associate's degree and bachelor's degree): biology, philosophy, physics, geography, history and chemistry.

Methods

Student population, courses and university

Our survey was carried out on first-year and fourth-year students at Londrina State University. These years were chosen because we wanted to see if the period in Londrina State University changes the students' ideas about evolution and the origin of life and the Universe. The questionnaire was administered in the years 2006 and 2007 in the following curricula (associate's degree and bachelor's degree): biology, philosophy, physics, geography, history and chemistry. The questionnaire was always filled out by the students just before or after a regular class. The terms of agreement were always read for the student by the one in charge of administering the questionnaire (always one of the authors), and a form was signed by the students agreeing to participate in the research before they started answering the questionnaire. Those students who did not agree to participate (only a few) were asked to leave the questionnaire on the desk. Londrina State University is located in south of Brazil in the north of Paraná State, 390 km from the state capital Curitiba. The university was founded in 1970, and the staff has about 1600 professors and 3600 employees (technicians, office personnel, general services, etc). The university has about 14 000 undergraduate students and 3400 graduate students (PhD and Master programmes, medical residence, etc). It should be pointed out that the university has 14 programs for PhDs and 33 programs for master's degrees. Thus, scientific research in some fields is well established.

The questionnaire

The questionnaire used in this research was provided by Dr. J.R. Downie of the University of Glasgow. It was modified according to the Brazilian case after a pilot test carried out in 2005. The total number of questionnaires filled out was

Table 1. *Socio-economic survey of students*

	Graduation course[1] (%)						Total (%)
	BIO	PHI	PHY	GEO	HIS	CHE	
Sex							
• Male	32.8	64.8	86.8	58.2	48.5	50.5	54.6
• Female	67.2	35.2	13.2	41.8	51.5	49.5	45.4
High school[2]							
• Public	36.2	69.0	55.8	68.8	63.0	59.9	57.9
• Private	59.2	26.8	36.4	25.4	30.9	34.9	36.4
• Public and private	4.6	4.2	7.8	5.8	6.1	5.2	5.7
Level of education of parents[3]							
• College	43.1	21.3	30.7	25.9	21.4	25.3	28.6
• High school	38.0	31.2	37.4	26.4	34.1	32.2	33.0
• Others	18.9	47.5	31.9	47.7	44.6	42.5	38.4
Average family income							
• 1–5 times minimum salary	26.2	65.7	53.2	62.9	60.5	44.5	50.5
• 6–10 times minimum salary	43.0	24.3	30.2	24.7	25.3	31.9	30.5
• 11–15 times minimum salary	21.5	8.6	10.3	7.5	11.1	15.7	13.0
• More than 15 times minimum salary	9.3	1.4	6.4	4.9	3.1	7.8	5.9
Attended religion class[4]	84.8	87.3	81.4	84.0	81.0	85.4	83.8
Number interviewed	174	71	129	189	165	192	920

[1] BIO – Biology, PHI – Philosophy, PHY – Physics, GEO – Geography, HIS – History and CHE – Chemistry.
[2] Where the students attended high school.
[3] The parents (mother and father) were divided into the following groups: college (completed college and/or post graduation), high school (incomplete college plus completed high school) and others (incomplete high school plus completed elementary school plus incomplete elementary school plus illiterate).
[4] At school, church or both.

about 920, where the first page begins with a preface about the status of the theory of evolution among professional biologists (overwhelmingly accepted) and the general public (not so sure). Afterwards, there is a section designated objective, where the main goals of the research and terms of agreement are pointed out. The second and third pages of the questionnaire consist of two parts: a socio-economic survey of the students and 11 multiple-choice questions referring to the degree of acceptance/rejection of the themes related to the origin and evolution of the Universe and life, as well as questions related to more common scientific themes. A copy of the complete questionnaire is available from the authors upon request. The questionnaire, as well as the project, was approved by the Ethics Committee on Research in Humans of Londrina State University (number 178-05, 15 August 2005).

Results

Table 1 shows the results of the socio-economic survey of the students. The biology course showed the highest scores for students who attended high school in private schools, level of education of the parents and family income. The students of philosophy had the lowest scores. It can be observed that, on average, less than 30% of students have parents who have some college education and more than 80% had religious instruction at school or church or both.

Eight different statements related to biological evolution were offered to students who could choose one or more of them (Table 2). The statement 'I accept evolution and I believe this does not discard the existence of God' had the highest score among the students interviewed (from 41.5% of philosophy students up to 71.3% of biology students). The statement 'I accept evolution because it is clear and unambiguous' was chosen by 25.3% of the interviewees studying biology, but only by 8.0% of chemistry students. The statement 'I accept evolution because I do not think there are any good alternatives to evolution that explain well the origin and distribution of the species' was chosen by 18.0% (the lowest) of interviewees studying chemistry and by 37.9% (the highest) of biology students. For the statement 'I do not accept (evolution) because I accept the literal truth of a religious creation as described in the Bible', the interviewees studying philosophy showed the lowest percentage (2.4%) of those who do not accept evolution because of their religious beliefs. However, those studying geography showed the highest percentage (13.9%). This statement was chosen by only 3.4% of the biology students interviewed. The statement 'I have doubts because I did not have enough information during my academic training to have an opinion about this subject' was chosen by only 5.7% of biology students, but it was chosen by 14.6% of philosophy students. The other two statements (third and fifth) of Table 2 were rarely chosen by the students interviewed, meaning that they are not important.

Statements about biological evolution and age of Earth and the Universe, and a question on how reliable are science's explanations for physical, chemical and biological phenomena were also offered to students (Table 3). About 92.1%,

Table 2. *Percentage of students interviewed who chose one or more responses when asked 'you may have several possible reasons for accepting or rejecting evolution as the mechanism for producing the variety of living organisms'*

Statement	Graduation course[1] (%)					
	BIO	PHI	PHY	GEO	HIS	CHE
I accept evolution because it is clear and unambiguous.	25.3	17.1	18.5	15.8	14.6	8.0
I accept evolution because I do not think there are any good alternatives to evolution that explain well the origin and distribution of the species.	37.9	36.6	24.6	26.7	18.3	18.0
I accept evolution and I believe this does not discard the existence of God.	71.3	41.5	50.8	43.6	57.3	70.0
I tend to accept what my teachers say; they know the evidence much better than I do.	3.4	0.0	1.5	0.0	0.0	3.0
I have doubts because I did not have enough information during my academic training to have an opinion about this subject.	5.7	14.6	10.8	10.9	9.8	7.0
I do not accept because I think there are other good alternatives to evolution that can explain the origin and distribution of the species.	0.0	2.4	3.1	2.0	3.7	2.0
I do not accept because the evidence for evolution is full of conflicts and contradictions.	2.3	0.0	7.7	7.9	9.8	7.0
I do not accept because I accept the literal truth of a religious creation as described in the Bible.	3.4	2.4	7.7	13.9	4.9	10.0

[1] BIO – Biology, PHI – Philosophy, PHY – Physics, GEO – Geography, HIS – History and CHE – Chemistry.

Table 3. *Percentage of students interviewed who accepted as true different subjects about evolution, as well as other issues related to science*

Statements		Graduation course[1] (%)						Mean (%)
		BIO	PHI	PHY	GEO	HIS	CHE	
The Universe is very old and Earth is about 4.5 billion years old.		93.7	90.8	93.0	93.1	91.4	90.1	92.1
Biological evolution occurred on Earth and lasted hundreds of millions of years.		92.4	93.9	92.2	89.9	87.7	86.4	89.9
Evolution can promote adaptations such as resistance to antibiotics and insecticides.		94.8	97.1	93.8	98.9	95.2	94.8	95.8
As time goes on, organisms can change giving rise to a new species.		97.1	87.0	89.0	85.2	81.2	87.0	87.8
No evidence could convince me of biological evolution.		2.9	5.6	4.7	6.3	4.8	9.9	5.9
Do you believe that science gives reliable answers about physical, chemical and biological phenomena?	• *Yes*	61.6	40.3	70.3	41.8	46.7	53.1	52.7
	• *No*	0.0	3.0	0.8	1.1	0.6	1.6	1.0
	• *Sometimes*	38.4	56.7	28.9	57.2	52.7	45.4	46.3

[1] BIO – Biology, PHI – Philosophy, PHY – Physics, GEO – Geography, HIS – History and CHE – Chemistry.

89.9%, 95.8% and 87.8% of the students interviewed accepted that: the Universe and Earth are very old, biological evolution has occurred for millions of years, evolution can explain adaptations (resistance to antibiotics and insecticides) and the organisms can change giving rise to a new species, respectively. Among the university interviewees, the statement 'No evidence could convince me of biological evolution' was chosen by 2.9% of the biology students (lowest) and by 9.9% of the chemistry students (highest). The question 'Can science give reliable answers about physical, chemical and biological phenomena?' was answered with 'no' most often by philosophy students (3.0%). An average of 52.7% of all students interviewed answered 'yes' to this question and the highest scores were obtained among the students in physics (70.3%), biology (61.6%) and chemistry (53.1%). Regarding the results shown in Table 3, it can also be noted that the biology course had the lowest level of

rejection of the evolutionary process and the highest level of acceptance of the macroevolutionary process (origin of new species). An average of 46.2% of students answered that sometimes science could give reliable answers, and the highest scores for this answer were obtained among the geography students (57.2%), philosophy students (56.7%) and history students (52.7%).

Table 4 shows the students' rating of their belief in the certainty of five scientific subjects. The students could score certainty of science in these subjects as: well established, reasonably established or poorly established. For the relation between smoking and lung cancer, chlorofluorocarbon gases (CFCs) and destruction of the atmosphere's ozone layer, and shifting continents and the theory of tectonic plates, 80.8%, 78.2% and 78.0%, respectively, of the students interviewed indicated these themes as being well supported by science. For themes such as the origin of the Universe and evolution,

Table 4. *Students' rating of the certainty that science provides about several scientific subjects*

Subject	Rating[1]	Graduation course[2] (%)						Mean (%)
		BIO	PHI	PHY	GEO	HIS	CHE	
The Big Bang theory is a model of the origin of the	V	35.6	21.4	35.4	35.1	25.6	17.7	28.9
Universe that began after an explosion that occurred	R	47.7	35.7	44.1	49.7	44.5	50.5	46.7
15 billion years ago.	P	16.7	42.9	20.5	15.4	29.9	31.8	24.5
Smoking causes lung cancer.	V	91.4	50.0	83.6	73.0	81.8	87.5	80.8
	R	8.0	44.3	14.8	21.7	17.6	11.5	17.0
	P	0.6	5.7	1.6	5.3	0.6	1.0	2.2
The biological evolution has been	V	79.3	62.9	68.8	63.3	57.3	58.3	65.0
occurring on Earth over hundreds of millions of years.	R	15.5	28.6	25.0	31.4	32.3	32.3	27.6
	P	5.2	8.6	6.3	5.3	10.4	9.4	7.4
The continents are not fixed in position, but move relative to	V	89.1	67.1	78.1	88.8	70.3	67.7	78.0
one another due to the movement of tectonic plates.	R	10.3	24.3	20.3	10.1	26.7	29.2	19.6
	P	0.6	8.6	1.6	1.1	3.0	3.1	2.4
Chlorofluorocarbon gases (CFCs), mainly from aerosol sprays,	V	87.9	43.5	80.5	77.2	73.8	84.9	78.2
are seriously depleting the atmosphere's ozone layer.	R	11.5	49.3	18.0	21.2	23.8	13.0	19.8
	P	0.6	7.2	1.6	1.6	2.4	2.1	2.1

[1] V – Very well established, R – Reasonably established and P – Very poorly established.
[2] BIO – Biology, PHI – Philosophy, PHY – Physics, GEO – Geography, HIS – History and CHE – Chemistry.

only 28.9% and 65.0%, respectively, of the students interviewed indicated that science has well-established proof. The percentage of the students that chose the option that some subjects are poorly established by science was low for smoking causes lung cancer (2.2%), the continents are not fixed (2.4%) and CFCs destroy the atmosphere's ozone layer (2.1%). When the subject was evolution, 7.4% of the students indicated that this is poorly established by science, and when the subject was the origin of the Universe this number jumped to 24.5%.

The rating of acceptance for several questions about the age of Earth and the Universe, and biological evolution and how reliable science is in answering questions about physical, chemical and biological phenomena are shown in Table 5. In Table 6 the students were asked to choose if they believe that different themes are very well established (V) or reasonably established (R) or poorly established (P) by science (Table 6). In both situations, the interviewees were divided into groups according to their religious belief, level of education of parents and family income. The religion of the students had no effect ($p > 0.050$) on the trust that they had about the answers that science can give to explain physical, chemical and biological phenomena (Table 5). On the other hand, the religion of the students had an effect on acceptance of the age of Earth and the Universe and evolution, and for the questions involving biological evolution the level of significance was $p < 0.010$. It should also be pointed out that for the statement 'No evidence could convince me of biological evolution', 24.7% of the students in group B (Christian, not Roman Catholic) chose it versus only 6.0% and 1.4% of the students in groups A (Christian, Roman Catholic) and C (Others), respectively (Table 5). Regarding the sentences presented in Table 6, only 9.5% of the students in group B versus 25.1% and 35.2% of the students in groups A and C, respectively, believed that the

big bang theory is very well established by science, and 56.8% of the students in group B believed that the big bang theory is poorly established by science versus 21.9% and 23.9% of the students in groups A and C, respectively. For the statement about biological evolution, only 28.1% of the students in group B versus 62.8% and 74.6% of students in groups A and C, respectively, believed that it is very well established, and 31.3% of the students in group B believed that it is poorly established versus 6.3% and 5.6% of the students in groups A and C, respectively.

The levels of parental education and family income seem to have a significant influence on the degree of rejection or acceptance of issues related to the origin of the Universe and Earth, and biological evolution (Tables 5 and 6). For example, the level of education of the mother appears to influence the acceptance of the age of the Universe and Earth ($p < 0.050$), biological evolution operating over millions of years ($p < 0.050$), the origin of new species ($p > 0.050$) (Table 5) and plate tectonics ($p > 0.050$) (Table 6). Regarding the level of education of the father with respect to such matters, this proved insignificant only to the origin of new species (Table 5).

Discussion

The high scores of family income in the course of biology (Table 1) can be explained by the fact that this is offered full time. The biology students came from families whose parents could afford to support their study without the students having to work. On the other hand, most students of philosophy, which is offered at night, had to work because of the low-income status of their family. It should be noted that, although Londrina State University is a public university where students do not pay any fees, students of low-income

Table 5. *Rating of acceptance and belief that students have about several themes involving the origin of the Universe and biological evolution*

Belief		Religion[1]	Level of education[2] Mother	Father	Family income[3]
Do you accept that the Universe is very old and Earth is about 4.5 billion years old?	A	330 (90.4%)	184 (88.5%)	182 (91.9%)	531 (90.3%)
	B	78 (82.1%)	109 (89.3%)	133 (85.3%)	134 (95.7%)
	C	66 (93.0%)	270 (91.8%)	278 (92.4%)	162 (95.3%)
	D	–	273 (96.1%)	231 (97.1%)	–
	χ^2	6.593*	11.375**	18.456**	7.492*
Do you accept that biological evolution has been occurring on Earth for hundreds of millions of years?	A	328 (89.6%)	179 (85.2%)	181 (91.0%)	515 (87.6%)
	B	59 (61.5%)	105 (87.5%)	126 (81.3%)	132 (95.0%)
	C	65 (94.2%)	260 (89.0%)	268 (89.6%)	156 (92.9%)
	D	–	269 (95.1%)	224 (94.1%)	–
	χ^2	52.782**	14.215**	17.194**	8.843*
Do you accept that evolution can operate in species promoting adaptations such as resistance to antibiotics (bacteria) and insecticides (insects)?	A	356 (97.0%)	200 (94.3%)	195 (96.5%)	563 (94.9%)
	B	86 (89.6%)	117 (95.9%)	147 (93.6%)	136 (97.1%)
	C	69 (97.2%)	282 (94.9%)	291 (96.0%)	167 (97.1%)
	D	–	277 (97.5%)	228 (95.8%)	–
	χ^2	10.604**	3.724ns	2.049ns	2.345ns
Do you accept that as time goes on, organisms can change giving rise to a new species?	A	326 (88.8%)	176 (83.0%)	175 (86.6%)	509 (86.0%)
	B	60 (62.5%)	105 (86.1%)	130 (83.3%)	125 (89.9%)
	C	64 (90.0%)	262 (88.5%)	271 (89.7%)	157 (91.3%)
	D	–	258 (91.2%)	212 (89.1%)	–
	χ^2	41.921**	7.959*	4.562ns	4.267ns
No evidence could convince me of biological evolution.	A	22 (6.0%)	16 (7.5%)	11 (5.4%)	39 (6.6%)
	B	24 (24.7%)	8 (6.6%)	18 (11.4%)	8 (5.7%)
	C	1 (1.4%)	20 (6.7%)	15 (5.0%)	7 (4.1%)
	D	–	10 (3.5%)	10 (4.2%)	–
	χ^2	39.211**	4.427ns	10.266*	1.507ns

Belief		%				%				%				%			
		Y	N	S	T	Y	N	S	T	Y	N	S	T	Y	N	S	T
Do you believe that science can give reliable answers about physical, chemical and biological phenomena?[4]	A	46.0	0.8	51.5	367	48.1	0	51.9	210	48.7	0.5	50.8	199	48.9	1.4	47.9	591
	B	32.3	3.1	62.5	96	42.6	3.3	52.5	122	50.3	3.8	43.9	157	60.0	0.7	38.6	140
	C	52.1	1.4	45.1	71	55.6	1.7	40.7	295	49.5	0.3	48.2	301	60.4	0	37.9	169
	D	–	–	–	–	58.0	0	39.6	283	60.9	0.4	36.1	238	–	–	–	–
	χ^2	10.210ns				29.685**				30.394**				12.648*			

The students were divided into groups according to religion, the level of education of parents and family income.

[1] The analysis was carried out with the number of students who self-reported in the questionnaire as to having or not a religion. The students were divided into the following religious groups: A – Christian Roman Catholic, B – Christian not Roman Catholic and C – Others (all non-Christian religions, Atheists, etc).

[2] Groups: A – illiterate plus incomplete elementary school, B – completed elementary school plus incomplete high school, C – completed high school plus incomplete college and D – completed college plus post graduation.

[3] Groups: A – from 1 to 5 times minimum salary, B – from 6 to 10 times minimum salary and C – 11 times minimum salary or more.

[4] Y – yes, N – no, S – sometimes and T – total students.

* Level of significance of 5%. ** Level of significance of 1%. ns Not significant.

families have to work to help to support their families. The other courses shown in Table 1 have both students that study full time and those whose study consists of night classes, and thus the scores are intermediate with respect to philosophy and biology students.

The results shown in Table 2 indicate that the level of rejection of evolutionary theory is relatively low, with the majority of students surveyed seeing no conflict between religion and evolution. Hansson & Redfors (2006) obtained similar results with Swedish secondary students regarding the origin and evolution of the Universe. According to those students, their belief in a god does not exclude a belief in the physical view of this issue. However, even among students of biology, there are individuals who do not accept the theory of evolution for religious reasons (3.4%). This rejection rate is relatively lower than that observed in the courses of physics, chemistry and geography. Ingram & Nelson (2006) studied the acceptance of evolution by undergraduate students in biology, and they found that these students overwhelmingly reject typical creationist arguments against evolution. In part, this lower level of rejection may be related to the profile of those who choose the biology course. Although there is no

Table 6. *Students' rating of the certainty that science provides about several scientific subjects*

		Religion[1]				Level of education[2] Mother				Father				Family income[3]			
		%				%				%				%			
		V	M	P	T	V	M	P	T	V	M	P	T	V	M	P	T
The big bang theory is a model of the origin of the Universe that began after an explosion that occurred 15 billion years ago.	A	25.1	53.0	21.9	366	26.1	46.9	27.0	211	28.0	48.5	23.5	200	24.4	46.6	29.0	590
	B	9.5	33.7	56.8	95	18.2	50.4	31.4	121	23.1	41.0	35.9	156	38.3	46.8	14.9	141
	C	35.2	40.8	23.9	71	28.7	45.9	25.3	296	27.5	50.0	22.5	302	36.8	46.2	17.0	171
	D	–	–	–	–	35.6	45.4	19.0	284	35.6	44.8	19.7	239	–	–	–	–
	χ^2		52.233**				16.731*				19.053**				26.274**		
Smoking causes lung cancer.	A	83.4	14.4	2.2	367	79.6	16.1	4.3	211	80.0	17.0	3.0	200	80.4	17.5	2.0	593
	B	83.5	15.5	1.0	97	82.8	15.6	1.6	122	78.5	18.4	3.2	158	82.3	14.9	2.8	141
	C	85.9	9.9	4.2	71	80.8	17.5	1.7	297	82.2	15.8	2.0	303	80.1	17.5	2.3	171
	D	–	–	–	–	81.1	17.5	1.4	285	81.2	17.6	1.3	239	–	–	–	–
	χ^2		2.999ns				5.917ns				2.914ns				0.899ns		
Biological evolution has been occurring on Earth for hundreds of millions of years.	A	62.8	30.9	6.3	366	56.4	31.3	12.3	211	58.8	33.2	8.0	199	58.6	31.9	9.5	592
	B	28.1	40.6	31.3	96	52.5	40.0	7.5	120	54.4	32.9	12.7	158	75.0	22.9	2.1	140
	C	74.6	19.7	5.6	71	66.0	27.3	6.7	297	67.5	24.5	7.9	302	78.9	15.8	5.3	171
	D	–	–	–	–	75.4	20.0	4.6	285	74.5	22.2	3.3	239	–	–	–	–
	χ^2		71.630**				33.935**				26.124**				34.332**		
The continents are not fixed in position, but move relative to one another due to the movement of tectonic plates.	A	74.9	23.4	1.6	367	74.9	23.2	1.9	211	76.5	21.5	2.0	200	75.5	21.8	2.7	592
	B	67.7	24.0	8.3	96	74.6	19.7	5.7	122	73.2	21.0	5.7	157	81.6	14.9	3.5	141
	C	84.5	12.7	2.8	71	76.4	20.9	2.7	297	77.6	19.5	3.0	303	83.0	16.4	0.6	171
	D	–	–	–	–	83.5	15.5	1.1	284	82.8	17.2	0.0	239	–	–	–	–
	χ^2		16.241**				13.833*				15.777*				8.482ns		
Chlorofluorocarbon gases (CFCs), mainly from aerosol sprays, are seriously depleting the atmosphere's ozone layer.	A	81.2	18.3	0.5	367	76.3	22.7	0.9	211	73.5	24.5	2.0	200	75.8	22.3	1.9	592
	B	73.2	24.7	2.1	97	72.1	24.6	3.3	122	73.2	22.3	4.5	157	80.1	16.3	3.5	141
	C	77.5	16.9	5.6	71	76.4	20.9	2.7	297	80.1	18.5	1.3	302	84.7	13.5	1.8	170
	D	–	–	–	–	84.1	14.1	1.8	283	83.7	14.6	1.7	239	–	–	–	–
	χ^2		13.122*				11.992ns				13.538*				9.196ns		

The students were divided into groups according to religion, the level of education of parents and family income.

[1] The analysis was carried out with the number of students who self-reported in the questionnaire as to having or not a religion. The students were divided into the following religious groups: A – Christian Roman Catholic, B – Christian not Roman Catholic and C – Others (all non-Christian religions, Atheists, etc).

[2] Groups: A – illiterate plus incomplete elementary school, B – completed elementary school plus incomplete high school, C – completed high school plus incomplete college and D – completed college plus post graduation.

[3] Groups: A – from 1 to 5 times minimum salary, B – from 6 to 10 times minimum salary and C – 11 times minimum salary or more.

* Level of significance of 5%. ** Level of significance of 1%. ns Not significant.

significant difference ($p > 0.050$) in the responses given by students of biology at the first and fourth grades, we should also draw attention to the fact that among the groups surveyed, the biology course is unique in offering the disciplines of genetics and evolution. According to Miller *et al.* (2006) and the Coalition of Scientific Societies (2008), knowledge of genetics is an important factor for the acceptance of evolution among adults.

A survey carried out by Downie (2004) with medical students showed that 10.8% of the students rejected the evolution theory, and the main reason was related to beliefs in the truth of creation as stipulated in the Bible. In general, when the statement 'I do not accept (evolution) because the evidence for evolution is full of conflicts and contradictions' was scored higher or lower, the same occurred for the statement 'I do not accept (evolution) because I accept the literal truth of a religious creation as described in the bible' (Table 2).

This relationship between these statements should be better investigated by other studies, because there may be a misunderstanding about how the science is conducted, and this may cause students to have a negative view of science.

Similar results in the rejection of evolutionary theory by students seen in this study (Table 3) were also obtained by Blackwell *et al.* (2003). In his research at the University of Alabama, 6.3% and 9.4% of general biology students and general studies students, respectively, indicated that they could never believe in evolution. Although the degree of rejection of biological evolution has been low, there was a slightly higher level of acceptance of the microevolutionary process in relation to the macroevolutionary process. However, it is important to note that this difference is not statistically significant ($p > 0.050$). However, it makes sense, considering that information relating to the microevolutionary process, such as the evolution of insect resistance to

pesticides or bacteria to antibiotics, are more present in their daily lives. Moreover, the origin of new species may require a greater degree of knowledge by students at the same time as it demands a deeper change in their religious beliefs. Dagher & Boujaoude (2005) and Lovely & Kondrick (2008) obtained similar results studying university students. Dagher & Boujaoude (2005) found that most of the interviewed Lebanese students agree that observational or experimental evidence exists for natural selection; however, the majority of the students found the extrapolations to be unlikely to support the claims of macroevolution. According to Lovely & Kondrick (2008), when the issue of human evolution from other living beings was not mentioned, the students could agree more easily with statements about evolution.

The fact that the higher scores for the 'yes' answer to the question 'Can science give reliable answers about physical, chemical and biological phenomena?' (Table 3) were found in chemistry, physics and biology courses was expected, since in these courses the students spend a great deal of time with laboratory experiments where they can see how science works. On the other hand, some students that chose the option for 'some times' also wrote phrases such as these: 'Science could be serving interests that make me suspicious of its ends' or 'Many times the "reliable answers" change with time and they are replaced by other reliable answers' or 'What is reliable? A theory is not absolute'. Although there is a high level of trust in science, these comments show that some students do not know how science works and some of them question whether all science is for their welfare.

For the students interviewed, it was observed that both biological evolution and the big bang theory appear to be less scientifically established than issues such as the relation between smoking and lung cancer, CFCs and destruction of the atmosphere's ozone layer, and shifting continents and the theory of tectonic plates (Table 4). It was surprising that even the physics students scored rather low (35.4%) on the point that the big bang theory is 'well established' by science. As mentioned previously, besides having a higher level of complexity, both evolutionary theory and the big bang theory may also interfere more directly with the religious beliefs of students. It should be pointed out that 5.9% (Table 3) of the students stated 'no evidence could convince me of biological evolution' and this is very close to the proportion of students stating that evolution is poorly established by science. The results of this study are consistent with other published studies. For example, theories such as heliocentrism, the cell or the atom (Scott 1997) or photosynthesis/respiration (Sinatra et al. 2003) are more easily accepted than the evolution theory. Table 4 also shows that the score depends on the exposure of the students to the subject: 84.9% of chemistry students indicated that the destruction of the atmosphere's ozone layer by CFCs is well established by science and 88.8% of geography students had the same opinion of science in regard to the theory of tectonic plates. Biology students had the highest percentage of those choosing that science is well established for the several statements in Table 4. However, the philosophy students showed the lowest scores. It was the

students of philosophy who raised a series of doubts about the certainty that science provides about several scientific subjects.

This study also showed a direct relationship between the religion of the students and the acceptance or rejection of evolutionary theory (Table 5). Among the religious groups, the lowest acceptance for questions involving evolution was group B, formed by Christian students, not Roman Catholic students, in which there were students from several religions (evangelist, etc) that are very conservative about questions on biological evolution. A study carried out in the U.S. showed that the acceptance of the evolution theory correlates negatively with religious fundamentalism (Coalition of Scientific Societies 2008). In a study with university undergraduates, Lombrozo et al. (2008) found that religiosity was significantly and negatively correlated with acceptance of evolution. Dagher & Boujaoude (1997) also showed a strong connection between the students' position regarding the theory and their religious affiliation. However, in group A, formed by Christian Roman Catholic students, it was also observed that students do not accept evolutionary theory. In this group, several comments appeared on the questionnaire such as: 'I am charismatic', 'I am a practicing Roman Catholic', 'I am not a practicing Roman Catholic', etc. This probably means that even in the group of Roman Catholic students, there are those who are very conservative about themes of biological evolution and the age of Earth and the Universe. Thus, further research is needed to investigate the relationship of the involvement of students with religion and acceptance of themes about biological evolution and the age of Earth and the Universe.

An interesting finding that emerged from this study is that the education level of parents and family income seems to have some effect on the acceptance of students with respect to biological evolution and the age of Earth and the Universe (Tables 5 and 6). This was also observed for the statement 'Do you believe that science can give reliable answers about physical, chemical and biological phenomena?' (Table 5). The level of parental education and family income are interrelated, in that families with a lower income are usually within the lower level of education. According to research carried out by the Coalition of Scientific Societies (2008), interviewees who answered correctly that continents or lands on which we live have been moving for millions of years and will continue to move in the future (79%), that antibiotics do not kill viruses as well as bacteria (43%) and that the first human beings did not live at the same time as dinosaurs (53%) were more inclined to answer that human beings, as well as other organisms, evolved (78%) and were more favourable to the study of evolutionism (78%). Thus, the level of education of the population plays an important role in the acceptance of biological evolution. Furthermore, in a study with American undergraduate students, Lombrozo et al. (2008) found that accepting evolution is significantly correlated with understanding the nature of science. They suggested that during the teaching of evolution it is important to emphasize the scientific method and give examples of

experimental evolutionary studies. A similar suggestion was made by Sinatra *et al*. (2003). In the present work the students were not asked if they had gained some information about the nature of science throughout their course. It may seem natural that it is present in undergraduate courses, particularly those with a tradition in basic and applied research. However, from the responses from many students, it appears that this issue seems to be little discussed with the students of our University.

Conclusion

It should be pointed out that the population of Brazilian students interviewed is very different from other countries cited in this research. Most Brazilian students are Roman Catholic, while in the U.S. most of the students are protestant and in Lebanon many students are Muslim. Thus, these results are unique.

About 50% of the students interviewed attended public high school and came from families whose total income was one to five times the minimum salary, and only about 29% came from families whose parents went to college. About 84% of the students interviewed attended religion classes.

About 14% of geography students did not accept the theory of evolution because they believed in creation as described in the Bible, but for philosophy students this percentage fell to 2.4% and for biology students 3.4%. For 5.9% of the students interviewed, no evidence could convince them that biological evolution occurred. However, between 41.5% (philosophy students) and 71.3% (biology students) did not see any conflict between religion and evolution. About 90% of the students interviewed accepted as true macro- and microevolution and that Earth and the Universe are billions of years old.

About 53% of the students interviewed believed that science can give reliable answers about physical, chemical and biological phenomena, and 1.0% were sceptical.

About 80% of the students believed the relationship between smoking and lung cancer, tectonic plates and continents not being fixed and the depletion of the ozone layer by CFCs are well established by science, but this number fell to 65% for biological evolution and 28.9% for the big bang theory. It should be pointed out that for 24.5% and 7.4% of all students, the big bang theory and biological evolution, respectively, are poorly supported by science.

Higher education of the parents also increased the acceptance by students of biological evolution and that Earth and the Universe are very old. The students who self-reported being Christian but not Roman Catholic were more conservative in their religious view of biological evolution and the age of Earth and the Universe than other groups of students. Family income had less effect on the acceptance of biological evolution and the old age of the Universe and Earth than religion and the level of education of parents. Religion had no effect on the trust that students had in science, but family income and the level of the education of parents did.

The students' rating on the certainty that science provides about biological evolution and the big bang theory was influenced by religion, the level of education of parents and family income.

In general, we can say that religion and the level of education of parents have a greater effect on students' acceptance of concepts related to the origin of the universe and biological evolution than other common themes of science.

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