

Educators of Prospective Teachers Hesitate to Embrace Evolution Due to Deficient Understanding of Science/Evolution and High Religiosity

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Abstract Acceptance of evolution by educators of prospective teachers remains superficially studied despite their role in having mentored school teachers whose weak support to evolution is known. Here, we contrast the views of New England educators of prospective teachers ($n=62$; 87% Ph.D./doctorate holders in 32 specializations) with those of the general faculty ($n=244$; 93% Ph.D./doctorate holders in 40 disciplines), both members of 35 colleges and universities, and with college students ($n=827$; subsample of the 35 institutions) who were polled on: (1) the controversy evolution vs. creationism vs. intelligent design (ID), (2) their understanding of how science/evolution works, and (3) their religiosity. The educators held intermediate positions in respect to the general faculty and the students: 94% of the general faculty, 75% of the educators, and 63% of the students admitted to accept evolution openly; and 82% of the general faculty, 71% of the educators, and 58% of the students thought that evolution is definitely true. Only 3% of the general faculty in comparison to 19% of the educators and 24% of the students thought that evolution and creationism are in harmony. Although 93% of the general faculty, educators, and students knew that evolution relies on common ancestry, 26% of the general faculty, 45% of the

educators, and 35% of the students did not know that humans are apes. Remarkably, 15% of the general faculty, 32% of the educators, and 35% of the students believed, incorrectly, that the origin of the human mind cannot be explained by evolution; and 30% of the general faculty, 59% of the educators, and 75% of the students were Lamarckian (=believed in inheritance of acquired traits). For science education: 96% of the general faculty, 86% of the educators, and 71% of the students supported the exclusive teaching of evolution, while 4% of the general faculty, 14% of the educators, and 29% of the students favored equal time to evolution, creationism and ID; note that 92% of the general faculty, 82% of the educators, and 50% of the students perceived ID as either not scientific and proposed to counter evolution based on false claims or as religious doctrine consistent with creationism. The general faculty were the most knowledgeable about science/evolution and the least religious (science index, $SI=2.49$; evolution index, $EI=2.49$; and religiosity index, $RI=0.49$); the educators reached lower science/evolution but higher religiosity indexes than the general faculty ($SI=1.96$, $EI=1.96$, and $RI=0.83$); and the students were the least knowledgeable about science/evolution and the most religious ($SI=1.80$, $EI=1.60$, and $RI=0.89$). Understanding of science and evolution were inversely correlated with level of religiosity, and understanding of evolution increased with increasing science literacy. Interestingly, $\approx 36\%$ of the general faculty, educators and students considered religion to be very important in their lives, and 17% of the general faculty, 34% of the educators, and 28% of the students confessed to pray daily. Assessing the perception of evolution by educators of prospective teachers vs. the general faculty and the students of New England, one of the historically most progressive regions in the U.S., is crucial for determining the magnitude of the impact of creationism and

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69 ID on attitudes toward science, reason, and the education
70 in science.

71 **Keywords** Antievolution wars · College education ·
72 Controversy science versus popular belief · Evolution
73 literacy · Evolution polls

74 **Introduction**

75 Creationism and intelligent design (ID) split the public’s
76 support to evolution in the U.S. (Padian 2009; Padian and
77 Matzke 2009; Forrest 2010; Matzke 2010; Paz-y-Miño-C
78 and Espinosa 2011a), where only 40% of adults accept the
79 concept of evolution (Miller et al. 2006; The Gallup Poll
80 2009). The U.S. ranks 33rd among 34 other industrialized
81 countries where acceptance of evolution has been polled, in
82 contrast to Iceland, Denmark, Sweden, France, Japan, and
83 the UK, top in the list, where ~75–85% of the general public
84 accepts evolution (Miller et al. 2006). In the intellectually
85 progressive Northeastern U.S. favorable views toward evo-
86 lution are the highest nationwide, only 59% (The Pew
87 Research Center for the People & the Press 2005).

88 The concept of evolution provides naturalistic explana-
89 tions about the origin of life, its diversification and bioge-
90 ography, and the synergistic phenomena resulting from the
91 interaction between life and the environment (Paz-y-Miño-C
92 and Espinosa 2011b); mutations, gene flow, genetic drift,
93 and natural selection shape life’s biological processes in
94 Earth’s ecosystems (Mayr 2001). Since the publication of
95 *The Origin of Species* by Charles Darwin, in 1859, Darwinian
96 evolution has been scrutinized experimentally; today the *the-*
97 *ory of evolution* is widely accepted by the scientific commu-
98 nity (Coyne 2009; Dawkins 2009; Paz-y-Miño-C and
99 Espinosa 2011a, b). In contrast, creationism, theistic evo-
100 lution, creation science, or young earth creationism
101 (Petto and Godfrey 2007; Matzke 2010; Phy-Olsen
102 2010) rely on supernatural causation to explain the origin
103 of the universe and life. These views are not recognized
104 by scientists as evidence-based explanations of empirical
105 reality (Padian 2009; Scott 2009; Paz-y-Miño-C and
106 Espinosa 2009a, b, 2011a), or of cosmic processes
107 which, according to modern understanding of “cosmic
108 evolution,” do encompass the formation of the universe, the
109 emergence of the simplest elements that transformed into
110 more complex elements and molecules, including prebiotic
111 compounds in our planet and that, ultimately, led to the
112 evolution of molecular diversity and complexity of today’s
113 living organisms and ecosystems (see Zaikowski et al. 2008;
114 Krauss 2010; Paz-y-Miño-C and Espinosa 2011b).

115 The doctrine of ID, born in the 1980s, proposes that a
116 designer is responsible, ultimately, for the assemblage of
117 complexity in biological systems; according to ID, evolution

cannot explain holistically the origin of the natural world, 118
nor the emergence of intricate molecular pathways essential 119
to life, nor the immense phylogenetic differentiation of life, 120
and instead ID proposes an *intelligent agent* as the ultimate 121
cause of nature (Pennock 2001; Young and Edis 2004; 122
Forrest and Gross 2007a, b; Miller 2007, 2008; Petto and 123
Godfrey 2007; Phy-Olsen 2010). In conceptually mistaken, 124
type-I-error-based arguments to discredit evolution, ID has 125
attributed randomness to molecular change, deleterious na- 126
ture to single-gene mutations, insufficient geological time or 127
population size for molecular improvements to occur, and 128
invoked “design intervention” to account for complexity in 129
molecular structures and biological processes (Paz-y-Miño- 130
C and Espinosa 2010; Paz-y-Miño-C et al. 2011). In 2005, 131
ID was exposed in court (Dover, Pennsylvania, Kitzmiller 132
et al. versus Dover School District et al. 2005; Padian 133
and Matzke 2009; Wexler 2010) for violating the rules of 134
science by “invoking and permitting supernatural causation” 135
in matters of evolution, and for “failing to gain acceptance 136
in the scientific community.” Today, “design creationism” 137
(as we refer to ID due to its designer/creator-based founda- 138
tions; Pennock 2001; Paz-y-Miño-C and Espinosa 2010, 139
2011b; Paz-y-Miño-C et al. 2011) although defeated by 140
science and in the courts, grows influential in the U.S., 141
Europe, Australia and South America (Cornish-Bowden 142
and Cárdenas 2007; Padian 2009; Branch et al. 2010; 143
Forrest 2010; Matzke 2010; Wexler 2010). 144

145 Acceptance of evolution among the general public, high 146
school students and teachers, college students, university 147
professors, and scientists has been documented (Bishop 148
and Anderson 1990; Downie and Barron 2000; Moore and 149
Kraemer 2005; Miller et al. 2006; Donnelly and Boone 150
2007; Moore 2007; Berkman et al. 2008; Hokayem and 151
BouJaoude 2008; Coalition of Scientific Societies 2008; 152
The Gallup Poll 2008, 2009; Berkman and Plutzer 2011; 153
Paz-y-Miño-C and Espinosa 2009a, b, 2011a), but the 154
patterns of acceptance of evolution at the college level and 155
its diverse subpopulations of students and faculty remain 156
only partly known (but see Paz-y-Miño-C and Espinosa 157
2009a, b, 2011a), the latter applies particularly to the 158
educators of future educators, that is college and university 159
faculty specialized in training prospective teachers.

160 We considered important to explore attitudes toward evo- 161
lution among those acting as educators of prospective teach- 162
ers for the following reasons: (1) acceptance of evolution 163
among school teachers, the “academic progeny” of the edu- 164
cators of prospective teachers, has been documented to be 165
low (e.g., 14–69% of school teachers question or reject 166
evolution; 40% do not accept human evolution; 43% are 167
willing to dedicate “equal time” to science and ID; 13% 168
explicitly advocate creationism and ID; and 20% would 169
agree to de-emphasize or omit evolution from their lessons 170
if pressured by students or parents; statistical details in

171 Moore 2002; National Science Teachers Association 2005;
 172 National Science Foundation 2006; Berkman and Plutzer
 173 2010, 2011) and sometimes even lower than the general
 174 public (e.g., 30% general public versus 47% high school
 175 biology teachers think that God guided human evolution;
 176 Berkman et al. 2008), still no connection has been proposed
 177 nor investigated between the views of these teachers about
 178 evolution and those of the scholars who trained them
 179 (=educators of future educators); (2) although attitudes
 180 toward evolution correlate positively with understanding of
 181 science/evolution and negatively with religiosity (Bishop
 182 and Anderson 1990; Downie and Barron 2000; Trani
 183 2004; Paz-y-Miño-C and Espinosa 2011a), these parameters
 184 have not been quantified in subpopulations of educators of
 185 prospective teachers (Paz-y-Miño-C and Espinosa 2011a);
 186 note that a cultural assumption has been that highly educat-
 187 ed faculty are consistently supportive of science and remain
 188 distant from belief-based perspectives about the natural
 189 world (but see Ecklund and Scheitle 2007; Gross and
 190 Simmons 2009); (3) because in a recent study we reported
 191 surprisingly high (30%) religiosity among New England
 192 professors (Paz-y-Miño-C and Espinosa 2011a), we
 193 suspected differential religiosity between the educators of
 194 prospective teachers versus the general faculty and, there-
 195 fore, lower levels of acceptance of evolution by the educa-
 196 tors in respect to the rest of the professors; this suspicion
 197 was also based on the predominantly theistic (=God guided)
 198 views about evolution held by current school teachers
 199 nationwide (data above; Berkman and Plutzer 2010, 2011);
 200 and (4) because acceptance of evolution increases with level
 201 of education, from high school graduates (20%; Brumfiel
 202 2005; The Gallup Poll 2009) to university professors (94%;
 203 Paz-y-Miño-C and Espinosa 2011a, this study), we consid-
 204 ered it relevant to quantify support to evolution by the
 205 Ph.D.- and doctorate-holder educators of prospective teachers
 206 in respect to the other populations (i.e., college students and
 207 professors outside the field of education).

208 Here we compare and contrast the views of a representa-
 209 tive sample of New England educators of prospective teach-
 210 ers ($n=62$) with those of the general faculty ($n=244$) and
 211 college students ($n=827$) who were polled in three areas
 212 (similar to Paz-y-Miño-C and Espinosa 2011a): (1) the
 213 controversy over evolution versus creationism versus ID,
 214 (2) their understanding of how science and the evolutionary
 215 process work, and (3) their religiosity. The samples of both
 216 educators of prospective teachers and the general faculty
 217 came from 35 colleges and universities; the students' data
 218 came from four representative New England institutions:
 219 public secular ($n=161$), private secular ($n=298$), religious
 220 I ($n=185$), and religious II ($n=183$). Assessing the percep-
 221 tion of evolution by educators of prospective teachers versus
 222 the general faculty and the students in one of the historically
 223 most progressive regions of the U.S. is crucial for determining

the magnitude of the impact of creationism and ID on attitudes 224
 toward science, reason, and the education in science (Paz-y- 225
 Miño-C and Espinosa 2011a). The New England states have 226
 among the highest evolution education standards in the 227
 U.S. (letter grade for coverage of evolution in state science 228
 standards: Connecticut *D*, Maine *C*, Massachusetts *B*, New 229
 Hampshire *A*, Rhode Island *B*, Vermont *B*; Mead and Mates 230
 2009), however only two out of three New Englanders accept 231
 evolution (above). By understanding opinions about evolution 232
 among subpopulations of higher education audiences, whose 233
 impact in the educational system and society is direct and/or 234
 imminent (e.g., “highly trained” educators of prospective 235
 teachers and general faculty, and “in-the-process-of-acquiring- 236
 education” students/future graduates), we aim at improving the 237
 approach with which evolution and science are communicated 238
 to the public at large, thus contributing to curricular/pedagog- 239
 ical reform for their effective teaching in college, and minimiz- 240
 ing the negative effects of creationism and ID on the U.S. 241
 educational system (Paz-y-Miño-C and Espinosa 2009a, b, 242
 2011a, b). 243

Methods 244

Because the statistical patterns of acceptance of evolution by 245
 educators of prospective teachers (the focus audience of this 246
 study) resulted in an intermediate position between the 247
 general faculty (highest scores) and the students (lowest 248
 scores), below we describe and refer to these three subpo- 249
 pulations in the following order: first, the general faculty 250
 (Gen Fac); second, the educators of prospective teachers 251
 (Edu); and third, the students (Stu). We keep this approach 252
 in tables and figures to facilitate the presentation of the data, 253
 analysis, and discussion. 254

We sampled general faculty and educators of prospective 255
 teachers affiliated with 35 academic institutions (17 colleges, 256
 18 universities) which were widely distributed geographically 257
 in all New England states (Connecticut, Maine, Massachusetts, 258
 New Hampshire, Rhode Island and Vermont; Tables 1 and 2, 259
 for institutional details see Table S1). In each state, we selected 260
 two public secular, two private secular and two religious 261
 colleges and/or universities, except for Maine where only one 262
 religious institution was identified (Table S1). We contacted 263
 via email (addresses obtained from institutional websites) 992 264
 general faculty according to two criteria (Paz-y-Miño-C and 265
 Espinosa 2011a): first, members of the biology departments, or 266
 close equivalents (e.g., ecology and evolutionary biology, mo- 267
 lecular and cell biology, natural sciences), of each institution 268
 (regardless of sex), who are usually highly educated in evolu- 269
 tion; and second, a similar number of nonbiology faculty, 270
 across 40 different disciplines, who were selected randomly 271
 (sex ratio 1:1; Table S1). We also contacted via email (same as 272
 in above) 506 educators of prospective teachers according to 273

Table 1 Descriptive statistics of the general faculty and educators of prospective teachers sampled per New England state

State ^a	Educators of prospective teachers ^b														
	General faculty ^b					Educators of prospective teachers ^b									
	Contacted		Responders			Contacted		Responders							
	No.	F (%)	M (%)	No. (%)	F (%)	M (%)	% in respect to total faculty completing survey	No.	F (%)	M (%)	No. (%)	F (%)	M (%)	% in respect to total educators completing survey	
t1.1															
t1.2															
t1.3															
t1.4															
t1.5															
t1.6															
t1.7															
t1.8															
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t1.11															
t1.12															
t1.13															
t1.14															
t1.15															
t1.16															
t1.17															
t1.18															
	Connecticut (CT)	159	73 (45.9) ^d	86 (54.1) ^d	38 (23.9) ^d	NA	NA	15.6 ^e	107	52 (48.6) ^d	55 (51.4) ^d	12 (11.2) ^d	NA	NA	19.4 ^e
	Subtotal	142	65 (45.8) ^d	77 (54.2) ^d	38 (26.8) ^d	NA	NA	15.6 ^e	64	37 (57.8) ^d	27 (42.2) ^d	6 (9.4) ^d	NA	NA	9.7 ^e
	Maine (ME)														
	Subtotal	144	62 (43.1) ^d	82 (56.9) ^d	34 (23.6) ^d	NA	NA	14.0 ^e	54	35 (64.8) ^d	19 (35.2) ^d	6 (11.1) ^d	NA	NA	9.7 ^e
	Massachusetts (MA)														
	Subtotal	215	89 (41.4) ^d	126 (58.6) ^d	50 (23.3) ^d	NA	NA	20.4 ^e	61	44 (72.1) ^d	17 (27.9) ^d	10 (16.4) ^d	NA	NA	16.1 ^e
	New Hampshire (NH)														
	Subtotal	178	77 (43.3) ^d	101 (56.7) ^d	41 (23.0) ^d	NA	NA	16.8 ^e	153	101 (66.0) ^d	52 (34.0) ^d	11 (7.2) ^d	NA	NA	17.7 ^e
	Rhode Island (RI)														
	Subtotal	154	74 (48.1) ^d	80 (51.9) ^d	43 (27.9) ^d	NA	NA	17.6 ^e	67	42 (62.7) ^d	25 (37.3) ^d	10 (14.9) ^d	NA	NA	16.1 ^e
	Vermont (VT)														
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7	NA	NA	11.3 ^e
	Un-identified state	992	440 (44.4) ^f	552 (55.6) ^f	244 (24.6) ^f	90 (36.9) ^e	154 (63.1) ^e		506	311 (61.5) ^f	195 (38.5) ^f	62 (12.3) ^f	37 (59.7) ^e	25 (40.3) ^e	
	Grand totals														

^a Data per state corresponds to 35 academic institutions (17 colleges, 18 universities) widely distributed geographically in New England; in each state, two public secular, two private secular and two religious colleges and/or universities were selected, except for Maine where only one religious institution was identified; for state by state institutional details see Table S1

^b General faculty were contacted according to two criteria: first, members of the biology departments, or equivalent, of each institution (regardless of sex), who are usually highly educated in evolution; and second, a similar number of nonbiology faculty, across all disciplines, who were selected randomly (sex ratio, 1:1). The nonbiologists corresponded to random selection of faculty from 40 different disciplines; for details about their fields of expertise see Table S1

^c Educators of prospective teachers were contacted according to three criteria: first, full time employees affiliated with one or multiple education departments, their subdivisions, programs and subprograms, or equivalents; second, individuals responsible for teaching students enrolled in education programs who, themselves, shall become educators; and third, educators affiliated with as many education subfields sponsored by their institutions, of which we identified 32 specializations; for details see Table S1

^d Percentage estimated in respect to sub total number of general faculty or educators of prospective teachers contacted per state

^e Percentage estimated in respect to total number of general faculty ($n=244$) or educators of prospective teachers ($n=62$) who responded to the survey

^f Percentage estimated in respect to grand total number of general faculty ($n=992$) or educators of prospective teachers ($n=506$) contacted to participate in the survey

Table 2 Profile of the general faculty, educators of prospective teachers, and college students who participated in the study

	General faculty No. (%)	Educators No. (%)	Students No. (%)	Grand Totals No. (%)
t2.4 Total	244 (21.5) ^a	62 (5.5) ^a	827 (73.0) ^a	1,133 (100) ^a
t2.5 Females	90 (36.9) ^b	37 (59.7) ^b	509 (61.5) ^b	636 (56.1) ^a
t2.6 Males	154 (63.1) ^b	25 (40.3) ^b	318 (38.5) ^b	497 (43.9) ^a
t2.7 PhD degree	220 (90.2) ^b	49 (79.0) ^b	NA	269 (23.7) ^a
t2.8 Doctorate degree	7 (2.9) ^b	5 (8.1) ^b	NA	12 (1.1) ^a
t2.9 Masters degree	17 (6.9) ^b	6 (9.7) ^b	NA	23 (2.0) ^a
t2.10 Bachelors degree	NA	2 (3.2) ^b	NA	2 (0.2) ^a
t2.11 Freshman	NA	NA	213 (25.8) ^b	213 (18.8) ^a
t2.12 Sophomore	NA	NA	192 (23.2) ^b	192 (16.9) ^a
t2.13 Junior	NA	NA	182 (22.0) ^b	182 (16.1) ^a
t2.14 Senior	NA	NA	240 (29.0) ^b	240 (21.2) ^a
t2.15 New England	104 (42.6) ^{bc}	25 (40.3) ^{bc}	630 (76.2) ^{bc}	759 (67.0) ^a
t2.16 East Coast	43 (17.6) ^{bd}	15 (24.2) ^{bd}	124 (15.0) ^{bd}	182 (16.1) ^a
t2.17 Other states	67 (27.5) ^{be}	21 (33.9) ^{be}	50 (6.0) ^{be}	138 (12.2) ^a
t2.18 Foreign countries	30 (12.3) ^{bf}	1 (1.6) ^{bf}	23 (2.8) ^{bf}	54 (4.7) ^a

^a Percentages in respect to grand total number of participants or “responders” to the survey ($n=1,133$), which is a fraction of the number of general faculty ($n=992$) plus educators of prospective teachers ($n=506$) and students ($n=17,621$; institutions: public=7,982, private=3,806, religious I=3,910, religious II=1,923) contacted via email and asked to take part in the study. For statistical details concerning profiles of those contacted, all responders, and their institutional affiliations and profiles see Tables S1 and S2

^b Percentages in respect to total number of participants per group of general faculty ($n=244$), educators of prospective teachers ($n=62$), and college students ($n=827$; institutions: public=161, private=298, religious I=185, religious II=183; see Table S2 for statistical details concerning students and their institutions)

^c New England: general faculty natives corresponded to MA, 13.7%; CT, 6.8%; VT, 6.8%; ME, 5.9%; NH, 4.9%; and RI, 4.5%; educators of prospective teachers natives corresponded to MA, 16.2%; RI, 9.7%; NH, 4.8%; VT, 4.8%; CT, 3.2%; and ME, 1.6%; and student natives corresponded to MA, 43.6%; RI, 13.7%; CT, 12.3%; NH, 3.5%; VT, 1.6%; and ME, 1.5%

^d East Coast: general faculty natives corresponded to NY, 9.6%; PA, 4.4%; NJ, 2.4%; MD and VA, 1.2%; educators of prospective teachers natives corresponded to NY, 12.9%; PA, 4.8%; MD, 3.3%; NJ, 1.6%; and VA, 1.6%; and students natives corresponded to NY, 7.3%; NJ, 3.8%; PA, 1.7%; MD, 1.2%; DE and VA, 1.0%

^e Other states: general faculty natives corresponded to CA, 7.3%; MI, 3.6%; CO and TX 2.5%; IL, 2.0%; OH, 1.6%; and 17 other states plus Puerto Rico, 10.5%; educators of prospective teachers natives corresponded to CA, 8.1%; FL, 3.2%; IL, 3.2%; WI, 3.2%; TX, 3.2%; MO, OK, OR plus Puerto Rico, 6.6%; and four unidentified states, 6.4%; and students natives corresponded to AZ, CA, CO, FL, GA, HI, IL, IN, KT, MI, MN, MO, NM, OH, OR, SC, TN, TX, WA, WI, plus Puerto Rico and four unidentified states, 6.0%

^f Foreign countries: general faculty corresponded to fifteen nationalities, including Europe and UK, 7.6%; Canada, 2.4%; and Australia, China, Libya, and Brazil, 2.3%; educators of prospective teachers corresponded to one UK nationality, 1.6%; and students corresponded to twenty nationalities, including Bosnia, Brazil, Canada, Cameroon, Cape Verde, Ecuador, France, Ghana, India, Japan, Korea, Latvia, Lebanon, Peru, Portugal, Philippines, Romania, Rwanda, UK, and Zimbabwe, 2.8%

274 three criteria: first, full-time employees affiliated with one or
 275 multiple education departments, their subdivisions, programs
 276 and subprograms, or equivalents; second, individuals respon-
 277 sible for teaching students enrolled in education programs
 278 who, themselves, shall become educators; and third, educators
 279 affiliated with as many education subfields sponsored by their
 280 institutions, of which we identified 32 specializations (Tables 1
 281 and 2, for statistical details see Table S1). To compare the
 282 views of both the New England general faculty and the
 283 educators of prospective teachers with those of college
 284 students, we surveyed students from four representative
 285 New England institutions (email requests to all enrolled stu-
 286 dents; $n=17,621$): public secular University of Massachusetts
 287 Dartmouth (UMassD Pub: 7,982 students contacted), private

secular Roger Williams University (RWU Priv: 3,806), 288
 religious I Providence College (PC Rel I: 3,910), and religious 289
 II Salve Regina University (SRU Rel II: 1,923) (Table 2; for 290
 detailed profiles of students and their institutions, see 291
 Table S2). Because the student population from the public 292
 secular institution was particularly large (45.3% of all 293
 students), we included one private (Priv) and two religious 294
 institutions (Rel I and II) to improve the representation of both 295
public versus *private* and *secular* versus *religious* student 296
 profiles in respect to the profiles of the Gen Fac and Edu, as 297
 follows: (1) Gen Fac and Edu contacted: 33.3% public 298
 versus 66.7% private; Stu contacted: 45.3% public versus 299
 54.7% private; and (2) Gen Fac and Edu contacted: 300
 66.7% secular versus 33.3% religious; Stu contacted: 301

302 66.9% secular versus 33.1% religious (percentages generated
303 from Tables S1 and S2).

304 General faculty, educators of prospective teachers, and
305 student profiles of those who responded to the survey were
306 comparable in respect to residency and workplace location
307 (New England states), but differed, as we expected, in
308 respect to place of birth (general faculty usually belong to
309 diverse cultural backgrounds: New England 42.6%, East
310 Coast 17.6%, other states 27.5%, foreign countries 12.3%;
311 educators of prospective teachers, as faculty themselves,
312 also belonged to diverse cultural backgrounds: New England
313 40.3%, East Coast 24.2%, other states 33.9%, foreign
314 countries 1.6%; and students mean Pub+Priv+Rel I+Rel II:
315 New England 76.2%, East Coast 15.0%, other states 6.0%,
316 foreign countries 2.8%; Table 2) and level of education
317 (general faculty: Ph.D. holders, 90.2%; doctoral degree or
318 equivalent, 2.9%; and masters degree, 6.9%; educators of
319 prospective teachers: Ph.D. holders, 79.0%; doctoral degree
320 or equivalent, 8.1%; masters degree, 9.7%; and bachelors
321 degree, 3.2%; and students mean Pub+Priv+Rel I+Rel II:
322 freshman, 25.8%; sophomore, 23.2%; junior, 22.0%; and
323 senior, 29.0%; Table 2).

324 One thousand one hundred and thirty three general
325 faculty ($n=244$, 21.5%), educators of prospective teachers
326 ($n=62$, 5.5%), and students ($n=827$, 73.0%) responded to a
327 ten-question anonymous and voluntary online survey (pro-
328 cedures similar to Paz-y-Miño-C and Espinosa 2009a, b,
329 2011a) to assess their views about evolution, creationism,
330 and intelligent design (questions 1–7, below), as well as
331 about their understanding of how the evolutionary process
332 works (questions 8–9, below), and their religiosity (question
333 10, below). The level of understanding of science was
334 assessed by asking three subquestions within the general
335 online survey (as in Paz-y-Miño-C and Espinosa 2011a;
336 for specifics see *Indexes* below). All participants were free
337 to withdraw from the survey at any time; no risks or
338 discomfort were involved in the study. The Institutional
339 Review Board of UMassD approved the general faculty
340 (surveyed during the first week of April and third week of
341 May 2010), the educators of prospective teachers (fourth
342 week of March and first week of April 2011) and UMassD
343 students' study (second week of September 2009), and the
344 Human Subjects/Institutional Review Boards of RWU (third
345 week of October 2009), PC (third week of April 2009), and
346 SRU (fourth week of April 2011) approved the surveying of
347 their own students. All participants answered questions
348 1–10 (but see exception in question 9, below) in order and
349 were instructed to not skip or go back to previous questions
350 to fix and/or compare answers. Questions 1–7 had five (a–e)
351 choices per question; questions 8–9 and 10 were true/false
352 and had five (a–e) or three (a–c) subcomponents (=each
353 true/false), respectively. All choices per question, including
354 the true/false options, were presented randomly and only

one choice was possible per question, except for questions 355
8–10 that allowed responders to select true or false in each 356
of the subcomponents (i.e., questions 8–9: true/false for a or 357
b or c or d or e; question 10: true/false for a or b or c). For 358
the purpose of reporting the data in this article and matching 359
the description of each question with the figure legends 360
(results, below), here we state the questions as follows 361
(similar to Paz-y-Miño-C and Espinosa 2009a, b, 2011a): 362

Questions Addressing Views about Evolution, Creationism, 363
and ID 364

Question 1: Evolution, creationism, and intelligent design in 365
the science class. Which of the following explanations about 366
the origin and development of life on Earth should be taught 367
in science classes? a=evolution, b=equal time to evolution, 368
creationism, intelligent design, c=creationism, d=intelligent 369
design, e=do not know enough to say. 370

Question 2: Intelligent design (ID). Which of the follow- 371
ing statements is consistent with ID? a=ID is not scientific 372
but has been proposed to counter evolution based on false 373
claims, b=ID is religious doctrine consistent with creation- 374
ism, c=no opinion, d=ID is a scientific alternative to evo- 375
lution and of equal scientific validity among scientists, 376
e=ID is a scientific theory about the origin and evolution of 377
life on Earth. 378

Question 3: Evolution and your reaction to it. Which of 379
the following statements fits best your position concerning 380
evolution? a=hearing about evolution makes me appreciate 381
the factual explanation about the origin of life on Earth and 382
its place in the universe, b=hearing about evolution makes 383
no difference to me because evolution and creationism are in 384
harmony, c=hearing about evolution makes me uncomfortable 385
because it is in conflict with my faith, d=hearing about evo- 386
lution makes me realize how wrong scientists are concerning 387
explanations about the origin of life on Earth and the universe, 388
e=do not know enough to say. 389

Question 4: Your position about the teaching of human 390
evolution. With which of the following statements do you 391
agree? a=I prefer science courses where evolution is dis- 392
cussed comprehensively and humans are part of it, b=I 393
prefer science courses where plant and animal evolution is 394
discussed but not human evolution, c=I prefer science 395
courses where the topic evolution is never addressed, d=I 396
avoid science courses with evolutionary content, e=do not 397
know enough to say. 398

Question 5: Evolution in science exams. Which of the 399
following statements fits best your position concerning 400
science exams? a=*general faculty* and *educators of prospec-* 401
tive teachers: instructors should have no problem giving 402
exams with questions concerning evolution, or *students*: I 403
have no problem answering questions concerning evolution, 404
b=science exams should always include some questions 405

<p>406 concerning evolution, c=<i>general faculty and educators of</i> 407 <i>prospective teachers</i>: students should prefer to not answer 408 questions concerning evolution, or <i>students</i>: I prefer to not 409 answer questions concerning evolution, d=<i>general faculty</i> 410 <i>and educators of prospective teachers</i>: students should never 411 answer questions concerning evolution, or <i>students</i>: I never 412 answer questions concerning evolution, e=do not know 413 enough to say.</p> <p>414 Question 6: Your willingness to discuss evolution. Select 415 the statement that describes you best: a=I accept evolution 416 and express it openly regardless of other’s opinions, b=no 417 opinion, c=I accept evolution but do not discuss it openly to 418 avoid conflicts with friends and family, d=I believe in 419 creationism and express it openly regardless of others’ 420 opinions, e=I believe in creationism but do not discuss it 421 openly to avoid conflicts with friends and family.</p> <p>422 Question 7: Your overall opinion about evolution (question 423 adapted from Miller et al. 2006). Select the statement with 424 which you agree most about “<i>evolution is</i>”: a=definitely true, 425 b=probably true, c=definitely false, d=probably false, e=do 426 not know enough to say.</p> <p>427 Questions Addressing Views about the Evolutionary 428 Process</p> <p>429 Question 8: An acceptable definition of evolution. Indicate 430 if each of the following definitions of evolution is either true 431 or false: a=gradual process by which the universe changes, 432 it includes the origin of life, its diversification and the 433 synergistic phenomena resulting from the interaction be- 434 tween life and the environment; b=directional process by 435 which unicellular organisms, like bacteria, turn into multi- 436 cellular organisms, like sponges, which later turn into fish, 437 amphibians, reptiles, birds, mammals and ultimately 438 humans, the pinnacle of evolution; c=gradual process by 439 which monkeys, such as chimpanzees, turn into humans; 440 d=random process by which life originates, changes, and 441 ends accidentally in complex organisms such as humans; 442 e=gradual process by which organisms acquire traits during 443 their lifetimes, such as longer necks, larger brains, resistance 444 to parasites, and then pass on these traits to their descendants.</p> <p>445 Question 9: Evidence about the evolutionary process. 446 Indicate if each of the following statements about evolution 447 is either true or false: a=all current living organisms are 448 descendants of common ancestors, which have evolved for 449 thousands, millions or billions of years; b=humans are apes, 450 relatives of chimpanzees, bonobos, gorillas, and orangutans; 451 c=the hominid (human lineage) fossil record is so poor that 452 scientists cannot tell with confidence that modern humans 453 evolved from ancestral forms; d=the origin of the human 454 mind and consciousness cannot be explained by evolution, 455 e=the universe, our solar system, and planet Earth are finely 456 tuned to embrace human life.</p>	<p>Question Addressing Responders’ Religiosity 457</p> <p>Question 10: Your religiosity. Indicate if each of the following 458 statements about religiosity is either true or false, select all that 459 apply (question adapted from Pew Global Attitudes Project 460 2007): a=faith in God is necessary for morality, b=religion is 461 very important in my life, c=I pray at least once a day. 462</p> <p>Understanding of Science, Evolution, and Religiosity 463 Indexes 464</p> <p>The Pew Global Attitudes Project (2007) has used the three 465 choices of Question 10 (above) to generate a religiosity 466 index (RI), a powerful predictor of religious views 467 worldwide (47 countries), which we applied to our 468 New England general faculty, educators of prospective 469 teachers, and students samples. RI ranges from 0 to 3 470 (least to most religious): +1 if responders believe that <i>faith in</i> 471 <i>God is necessary for morality</i>, +1 if <i>religion is very important</i> 472 <i>in their lives</i>, and +1 if <i>they pray daily</i>. 473</p> <p>To account for the levels of understanding of science and 474 the evolutionary process, we generated two descriptive in- 475 dexes (science index (SI), evolution index (EI); similar to 476 Paz-y-Miño-C and Espinosa 2011a), analogous to RI 477 (above). Thus, we could compare levels of understanding 478 of SI and EI with level of RI. Note that scholars in the field 479 of attitudes toward evolution have postulated (Bishop and 480 Anderson 1990; Downie and Barron 2000; Trani 2004; Paz- 481 y-Miño-C and Espinosa 2009a, b) and quantified (Paz-y- 482 Miño-C and Espinosa 2011a) that these three factors are 483 associated with an individual’s acceptance of evolution. 484 Our SI and EI range from 0 to 3 (lower to higher levels of 485 understanding of science and evolution) and rely on three 486 questions each, which were selected from a pool of five 487 questions about science and ten about evolution (all part of 488 the entire online surveys); the suitable questions for each 489 index showed variability between the responses by the gen- 490 eral faculty, the educators of prospective teachers, and the 491 students, and were, therefore, informative to discriminate 492 among the three groups: SI +1 if responders rejected the 493 idea that <i>scientific theories are based on opinions by scien-</i> 494 <i>tists</i>, +1 if they disagreed with the notion that <i>scientific</i> 495 <i>arguments are as valid and respectable as their non-</i> 496 <i>scientific counterparts</i>, and +1 if they rejected the statement 497 that <i>crime-scene and accident-scene investigators use a</i> 498 <i>different type of scientific method to investigate a crime or</i> 499 <i>an accident</i>; EI +1 if responders rejected the idea that 500 <i>organisms acquire beneficial traits during their lifetimes</i> 501 <i>and then pass on these traits to their descendants</i>, +1 if they 502 disagreed with the notion that <i>during evolution monkeys</i> 503 <i>such as chimpanzees can turn into humans</i>, and +1 if they 504 rejected the statement that <i>the origin of the human mind and</i> 505 <i>consciousness cannot be explained by evolution</i>. 506</p>
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507 Statistical Analyses

508 For the five-choice questions (1–7), we compared the New
 509 England general faculty (Gen Fac) versus the educators of
 510 prospective teachers (Edu) versus the college students from
 511 four types of academic institutions (Stu: Pub+Priv+Rel
 512 I+Rel II) and analyzed separately the data generated in each
 513 of the questions (i.e., questions 1, 2, 3, 4, 5, 6, or 7; choices
 514 a–e). Data from each question were organized in 3×5 con-
 515 tingency tables, for example, Gen Fac, Edu, Stu×a–e (chi-
 516 square tests, null hypotheses rejected at $P \leq 0.05$). Because
 517 questions 1, 3, 4, 5, 6, or 7 had none or very few responders
 518 (<5%; note that chi-square analyses are inaccurate when
 519 over 20% of the expected values are less than 5; Siegel
 520 and Castellan 1988) in one, two, or three of the choices
 521 (e or de or cde), we eliminated such choices and created
 522 3×2, 3×2, 3×2, 3×2, 3×3, and 3×2 contingency tables for
 523 the remaining groups in each question, respectively (chi-
 524 square tests, null hypotheses rejected at $P \leq 0.05$). For the
 525 true/false questions 8–9 and 10, we organized the data
 526 corresponding to each subcomponent of the question (ques-
 527 tions 8–9: subcomponents a–e; question 10: subcomponents
 528 a–c) in separate 2×3 contingency tables per each of the five
 529 or three subcomponents per question, respectively. For
 530 example, questions 8–9, subcomponents a or b or c or d or
 531 e (each separately): true, false×Gen Fac, Edu, Stu, and
 532 question 10, subcomponents a or b or c (each separately):
 533 true, false×Gen Fac, Edu, Stu (chi-square tests, null hypoth-
 534 eses rejected at $P \leq 0.05$). Note that for question 9, we could
 535 only sample students from the religious II institution (SRU
 536 Rel II), thus we compared general faculty versus educators
 537 of prospective teachers versus the compiled data of students
 538 from three institutions: Pub+Priv+Rel II. Pair-wise com-
 539 parisons between relevant groups in all questions were
 540 analyzed with sign test two-tail, null hypotheses rejected at
 541 $P \leq 0.05$. Although we instructed participants to not skip
 542 questions, they could do it freely (=human subjects/Institu-
 543 tional Review Boards' policies, above); therefore, the total
 544 number of general faculty, educators of prospective teach-
 545 ers, or student responders per question varied, as reported in
 546 the figure captions (below): Gen Fac mean=230, $r=216$ –
 547 244; Edu mean=55, $r=48$ –62; and Stu mean=681, $r=576$ –
 548 791 (note that 827 students responded as a whole to the 10
 549 questions in the survey, but a maximum of 791 students
 550 completed the question with the most responses, i.e., ques-
 551 tion 2; see caption in Fig. 2 below). The SI, EI, and RI
 552 indexes (above) did range from 0 to 3 each; we generated
 553 them for the general faculty, the educators of prospective
 554 teachers, and the students, and analyzed the raw data of each
 555 index separately as function of subpopulation (i.e., SI, Gen
 556 Fac versus Edu versus Stu; EI, Gen Fac versus Edu versus
 557 Stu; and RI, Gen Fac versus Edu versus Stu) with Kruskal–
 558 Wallis one-way analysis of variance (ANOVA) on ranks

(null hypotheses rejected at $P \leq 0.05$). Pair-wise comparisons
 between relevant groups in each index were analyzed
 with a two-tailed Dunn test (appropriate for unequal
 group size comparisons in rank-based ANOVA; Siegel
 and Castellan 1988), null hypotheses rejected at $P \leq 0.05$.
 Linear regression was used to analyze the association
 between the 0–3 levels of: SI (dependent variable) versus
 RI (independent variable), or EI (dependent variable)
 versus RI (independent variable), or EI (dependent vari-
 able) versus SI (independent variable) within each of the
 subpopulations (i.e., Gen Fac: SI versus RI, EI versus RI,
 and EI versus SI; Edu: SI versus RI, EI versus RI, and
 EI versus SI; and Stu: SI versus RI, EI versus RI, and EI
 versus SI) because we hypothesized directionality in the
 inverse association between level of understanding of
 science/evolution (dependent variables) and level of religiosity
 (independent variable), as well as a positive association
 between level of understanding of evolution (dependent vari-
 able) and level of understanding of science (independent
 variable), we used one-tail tests to reject null hypothesis
 at $P \leq 0.05$.

Results

Survey Response Rates and Representativeness of the Samples

General Faculty Two hundred and forty four (24.6%) of the
 992 general faculty contacted to participate in the study ($F=$
 44.4%, $M=55.6\%$; 40 disciplines) completed the survey
 (Table 1; see details in Table S1), a response rate compar-
 able to analogous email/online studies (=24%, The Pew
 Research Center for the People & the Press 2009). The
 average number of general faculty contacted per state
 was 165 ($r=142$ –215) and the average percent of res-
 ponders per state was 25 ($r=23.0$ –27.9; Table 1). Of all
 responders ($n=244$), 36.9% were females and 63.1%
 were males (Table 1).

Educators of Prospective Teachers Sixty-two (12.3%) of the
 506 educators of prospective teachers contacted to participate
 in the study ($F=61.5\%$, $M=38.5\%$; 32 specializations) com-
 pleted the survey (Table 1; see details in Table S1), a lower
 response rate than the general faculty (above) but consistent
 with the parameters of sample representativeness and statisti-
 cal confidence (see "Representativeness of the Samples and
 Statistical Confidence", below); note that scholars in survey
 methodology no longer attribute primary validity to response
 rates (Groves et al. 2009; Berkman and Plutzer 2011), but
 rather to demographic segmentation and low variance in
 responses (van Bennekom 2002), as in this study. The average
 number of educators of prospective teachers contacted per
 state was 84 ($r=54$ –153; Table 1) and the average percent of

607 responders per state was 12 ($r=7.2-16.4$; Table 1). Of all
 608 responders ($n=62$), 59.7% were females and 40.3% were
 609 males (Table 1).

610 *Students* Eight hundred and twenty-seven (4.7%) of the
 611 17,621 students contacted to participate in the study
 612 completed the survey (Table 2; see details in Table S2).
 613 Response rate by students varied among institutions: Pub
 614 161 (2.0% of 7,982 contacted), Priv 298 (7.8% of 3,806
 615 contacted), Rel I 185 (4.7% of 3,910 contacted), and Rel II
 616 183 (9.5% of the 1,923 contacted; Tables 2 and S2); these
 617 values were consistent with previous online sampling of
 618 these institutions where the demographic profile of partic-
 619 ipants in the surveys resembled closely the institutional
 620 profiles (Paz-y-Miño-C and Espinosa 2009a, b, 2011b). Of
 621 all responders ($n=827$), 61.5% were females and 38.5%
 622 were males (Tables 2 and S2).

623 *Representativeness of the Samples and Statistical Con-*
 624 *fidence* We consider our samples statistically representative
 625 of the New England general faculty, educators of prospective
 626 teachers, and students for the following reasons: (1) The
 627 demographic segmentation of responders (=percent of res-
 628 ponders per state and type of institution as function of the
 629 segmentation of those contacted) was in accordance with the
 630 demographics of the entire populations participating in the
 631 study (Tables 1, 2, S1 and S2); note that the response rate per
 632 state as function of those completing the survey was statisti-
 633 cally similar between Gen Fac and Edu (chi-square=2.150,
 634 $df=5$, $P=0.828$; data extracted from Table 1), as well as the
 635 Gen Fac and Edu demographic profiles for New England, East
 636 Coast, and other states in the U.S. (chi-square=1.116, $df=2$,
 637 $P=0.572$; data extracted from Table 2), but not when foreign
 638 countries were included in the comparison (chi-square=8.648,
 639 $df=3$, $P=0.034$; data extracted from Table 2) due to the
 640 rareness of international faculty (1.6%) among the educators
 641 of prospective teachers, the latter did not skew the pattern of
 642 responses. The students' demographic profiles closely
 643 matched those of the entire student populations at their insti-
 644 tutions, as well as their New England (76.2%) and East Coast
 645 (15%) upbringing (Tables 2 and S2); their responses were,
 646 therefore, pooled in a *single group of students* (Table 2) to
 647 homogenize their public-, private- secular or religious back-
 648 grounds, thus matching the students' profiles with those of the
 649 general faculty and the educators' (note that independent
 650 analysis of New England student views about evolution have
 651 been published; Paz-y-Miño-C and Espinosa 2009a, b,
 652 2011a); (2) the responses were tightly clustered (low variance
 653 is associated with satisfactory accuracy; see van Bennekom
 654 2002) in each sample of Gen Fac, Edu, and Stu that we used to
 655 generate the index SI (variance: Gen Fac=0.495, Edu=1.036,
 656 and Stu=0.910), EI (variance: Gen Fac=0.431, Edu=0.729,
 657 and Stu=0.682), and religiosity index RI (variance: Gen Fac=

0.703, Edu=1.028, and Stu=1.190), from which we drew 658
 broad conclusions about acceptance of evolution in the con- 659
 text of the responders' understanding of science/evolution and 660
 level of religiosity (see Figs. 11, 12, and Discussion); (3) the 661
 margin of error per sample at 95% certainty and 50% response 662
 distribution was consistent with conventional polling of public 663
 opinions of variable sizes (see van Bennekom 2002), as fol- 664
 lows: Gen Fac \pm 5.5%, Edu \pm 11.7%, and Stu \pm 3.3% (sample 665
 size calculator Raosoft 2011); note that by mentally adding 666
 and/or subtracting the margin of error values to/from the 667
 percentile responses in each question (results Figs. 1, 2, 3, 4, 668
 5, 6, 7, 8, 9 and 10, below) the differential response pattern 669
 between Gen Fac, Edu, and Stu persists; (4) the Gen Fac, Edu, 670
 and Stu held consistently high, middle, and low percentile 671
 levels of agreement/disagreement, respectively, in each of the 672
 ten survey questions (except for a nonstatistical difference in 673
 question 5; see Fig. 5); and (5) the response rates of the general 674
 faculty (24.6%), educators of prospective teachers (12.3%), 675
 and students (4.7%), in respect to the total populations con- 676
 tacted, were analogous to comparable studies of public opin- 677
 ions in the U.S. (The Pew Research Center for the People & 678
 the Press 2009) and consistent with our previous studies (Paz- 679
 y-Miño-C and Espinosa 2009a, b, 2011a); note observation 680
 about modern views on surveys validity based on response 681
 rates (above). 682

Views about Evolution, Creationism, and ID 684

Evolution, Creationism, and Intelligent Design in the Sci- 685
ence Class The general faculty, educators of prospective 686
 teachers and students differed in their views about the teach- 687
 ing of evolution (Fig. 1; chi-square=23.968, $df=2$, $P\leq$ 688
 0.001): 96.3% of the general faculty versus 86.2% of the 689
 educators of prospective teachers versus 70.7% of the stu- 690
 dents considered that evolution should be taught in science 691
 classes as an explanation about the origin and development 692
 of life on Earth; in contrast, 3.7% of the general faculty 693
 versus 13.8% of the educators of prospective teachers versus 694
 29.3% of the students favored equal time to evolution, 695
 creationism and intelligent design. Educators of prospective 696
 teachers had intermediate percentile level of support for the 697
 exclusive teaching of evolution between the general faculty 698
 (high) and the students (low), but were statistically similar to 699
 both groups; only the general faculty differed statistically 700
 from the students (sign test two-tail pair-wise comparison 701
 $P\leq 0.05$; Fig. 1). Although the general faculty support for 702
 the "equal time" option was negligible (3.7%), at least one 703
 in seven educators of prospective teachers (13.8%) and one 704
 in three students (29.3%) favored it (Fig. 1). Note that 705
 concerning the "equal time" option the views of each group 706
 were statistically different (sign test two-tail pair-wise com- 707
 parison $P\leq 0.05$; Fig. 1) and the educators of prospective 708
 teachers placed intermediate. 709

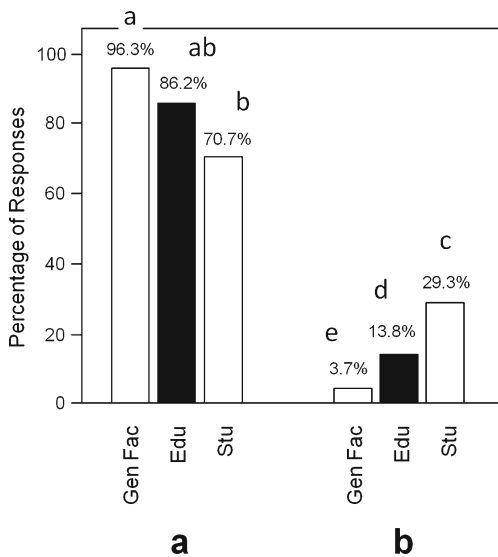


Fig. 1 Percentage of New England general faculty (*Gen Fac*, white bars left), educators of prospective teachers (*Edu*, black bars center) and college students (*Stu*, white bars right) who consider one of the following explanations about the origin and development of life on Earth should be taught in science classes: *a* evolution and *b* equal time to evolution, creationism, intelligent design. Comparisons among groups: chi-square=23.968, $df=2$, $P \leq 0.001$; lowercase letters indicate sign test two-tail pair-wise comparisons $P \leq 0.05$. *Gen Fac*, $n=241$; *Edu*, $n=58$; and *Stu*, $n=727$

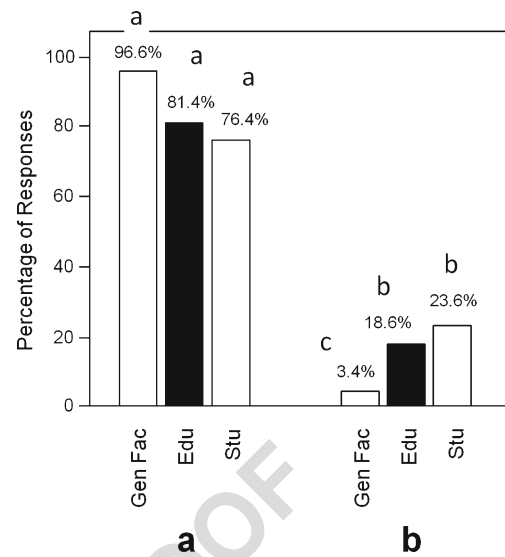


Fig. 3 Percentage of New England general faculty (*Gen Fac*, white bars left), educators of prospective teachers (*Edu*, black bars center) and college students (*Stu*, white bars right) who think one of the following statements fits best their position concerning evolution: *a* hearing about evolution makes me appreciate the factual explanation about the origin of life on Earth and its place in the universe; and *b* hearing about evolution makes no difference to me because evolution and creationism are in harmony. Comparisons among groups: chi-square=18.538, $df=2$, $P \leq 0.001$; lowercase letters indicate sign test two-tail pair-wise comparisons $P \leq 0.05$. *Gen Fac*, $n=236$; *Edu*, $n=59$; and *Stu*, $n=712$

710 *Intelligent Design* The general faculty and educators of pro-
 711 spective teachers had comparable opinions about ID, which
 712 differed from the students' variable perception of ID (Fig. 2;
 713 chi-square=50.836, $df=8$, $P \leq 0.001$): 46.7/45.5% of the gen-
 714 eral faculty and 41.9/40.3% of the educators of prospec-
 715 tive teachers versus 22.9/27.4% of the students perceived ID as

either not scientific and proposed to counter evolution based on 716
 false claims or as religious doctrine consistent with creation- 717
 ism, respectively. A small percent of the general faculty and 718
 educators of prospective teachers in comparison to a higher 719

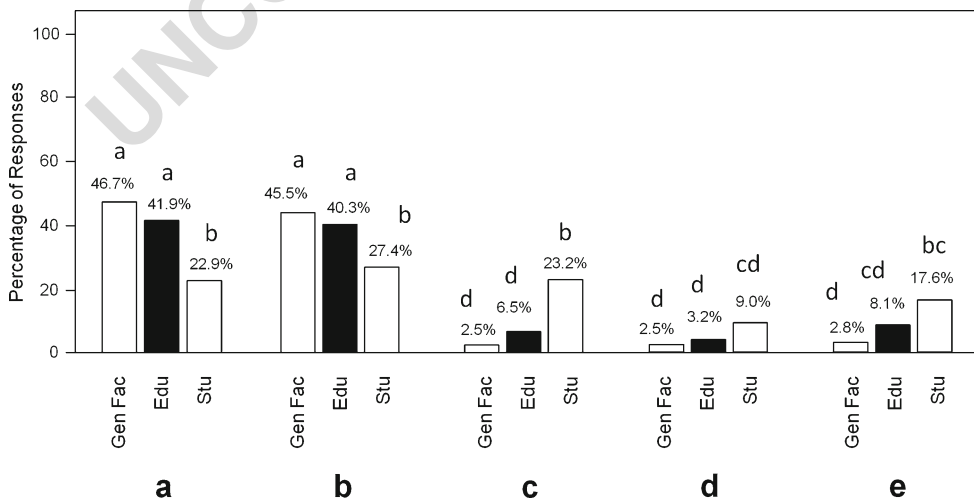


Fig. 2 Percentage of New England general faculty (*Gen Fac*, white bars left), educators of prospective teachers (*Edu*, black bars center) and college students (*Stu*, white bars right) who consider one of the following statements to be consistent with Intelligent Design (ID): *a* ID is not scientific but has been proposed to counter evolution based on false claims; *b* ID is religious doctrine consistent with creationism; *c* no

opinion; *d* ID is a scientific alternative to evolution and of equal 716
 scientific validity among scientists; and *e* ID is a scientific theory about 717
 the origin and evolution of life on Earth. Comparisons among groups: 718
 chi-square=50.836, $df=8$, $P \leq 0.001$; lowercase letters indicate sign test 719
 two-tail pair-wise comparisons $P \leq 0.05$. *Gen Fac*, $n=244$; *Edu*, $n=62$;
 and *Stu*, $n=791$

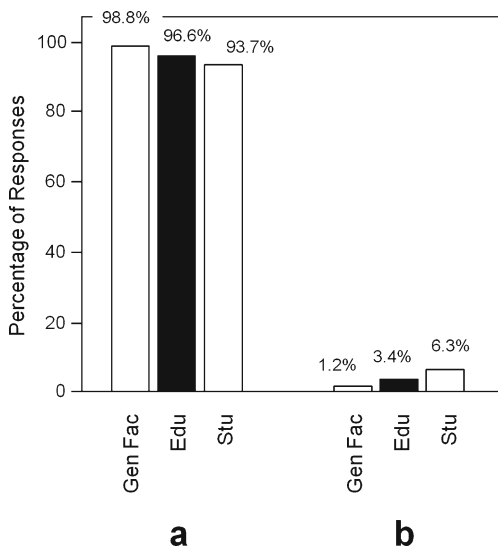


Fig. 4 Percentage of New England general faculty (*Gen Fac*, white bars left), educators of prospective teachers (*Edu*, black bars center) and college students (*Stu*, white bars right) who agree with one of the following statements concerning their own education: *a* I prefer science courses where evolution is discussed comprehensively and humans are part of it; and *b* I prefer science courses where plant and animal evolution is discussed but not human evolution. Comparisons among groups: chi-square=3.931, *df*=2, *P*=0.14. *Gen Fac*, *n*=242; *Edu*, *n*=59; and *Stu*, *n*=702

720 percent of students had either no opinion about ID (2.5%
 721 general faculty, 6.5% educators of prospective teachers,
 722 23.2% students), considered ID a scientific alternative to

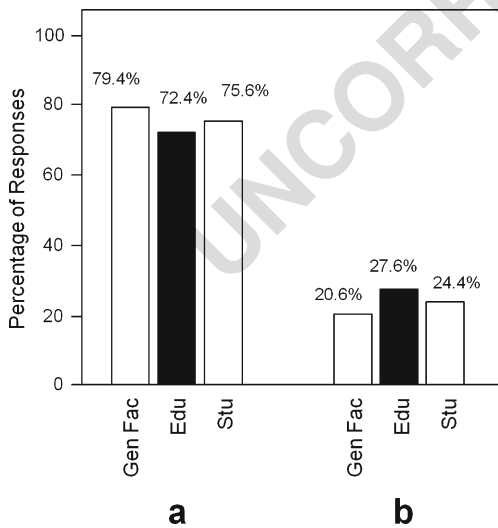


Fig. 5 Percentage of New England general faculty (*Gen Fac*, white bars left), educators of prospective teachers (*Edu*, black bars center) and college students (*Stu*, white bars right) who agree with one of the following statements concerning evolution in science exams: *a* *Gen Fac* and *Edu*: instructors should have no problem giving exams with questions concerning evolution, or *Stu*: I have no problem answering questions concerning evolution; and *b* science exams should always include some questions concerning evolution. Comparisons among groups: chi-square=1.34, *df*=2, *P*=0.512. *Gen Fac*, *n*=238; *Edu*, *n*=58; and *Stu*, *n*=711

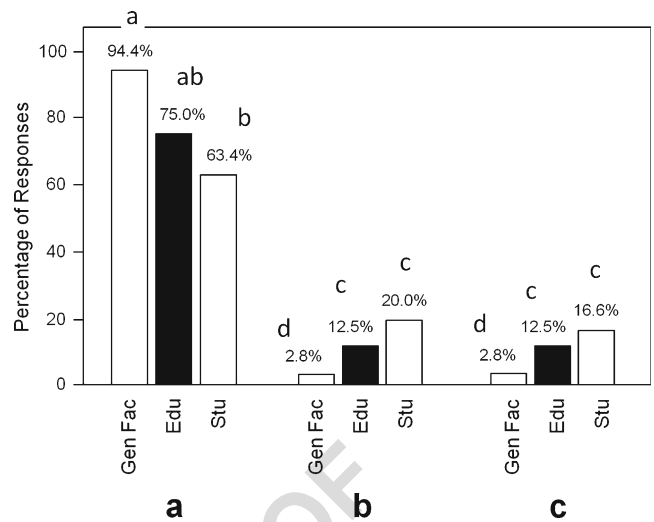


Fig. 6 Percentage of New England general faculty (*Gen Fac*, white bars left), educators of prospective teachers (*Edu*, black bars center), and college students (*Stu*, white bars right) who believe one of the following statements describes them best: *a* I accept evolution and express it openly regardless of others' opinions; *b* no opinion; and *c* I accept evolution but do not discuss it openly to avoid conflicts with friends and family. Comparisons among groups: chi-square=28.022, *df*=4, *P*≤0.001; lowercase letters indicate sign test two-tail pair-wise comparisons *P*≤0.05. *Gen Fac*, *n*=216; *Edu*, *n*=48; and *Stu*, *n*=695

723 evolution and of equal scientific validity among scientists
 724 (2.5% general faculty, 3.2% educators of prospective teachers,
 725 9.0% students), or thought of ID as a scientific theory about the
 726 origin of life on Earth (2.8% general faculty, 8.1% educators
 727 of prospective teachers, 17.6% students; sign test two-tail
 728 pair-wise comparisons *P*≤0.05; Fig. 2).

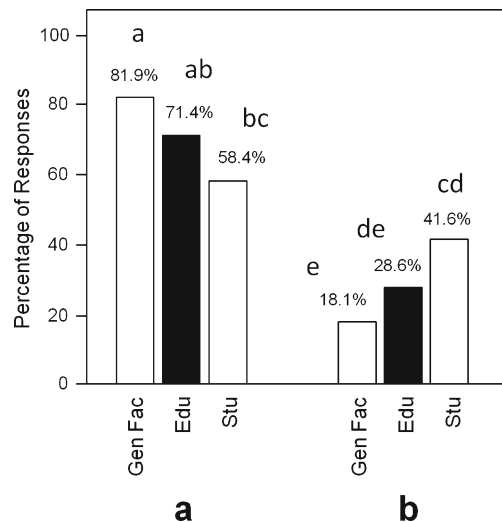


Fig. 7 Percentage of New England general faculty (*Gen Fac*, white bars left), educators of prospective teachers (*Edu*, black bars center) and college students (*Stu*, white bars right) who think evolution is: *a* a definitely true and *b* probably true. Comparisons among groups: chi-square=13.835, *df*=2, *P*≤0.001; small case letters indicate sign test two-tail pair-wise comparisons *P*≤0.05. *Gen Fac*, *n*=216; *Edu*, *n*=49; and *Stu*, *n*=677

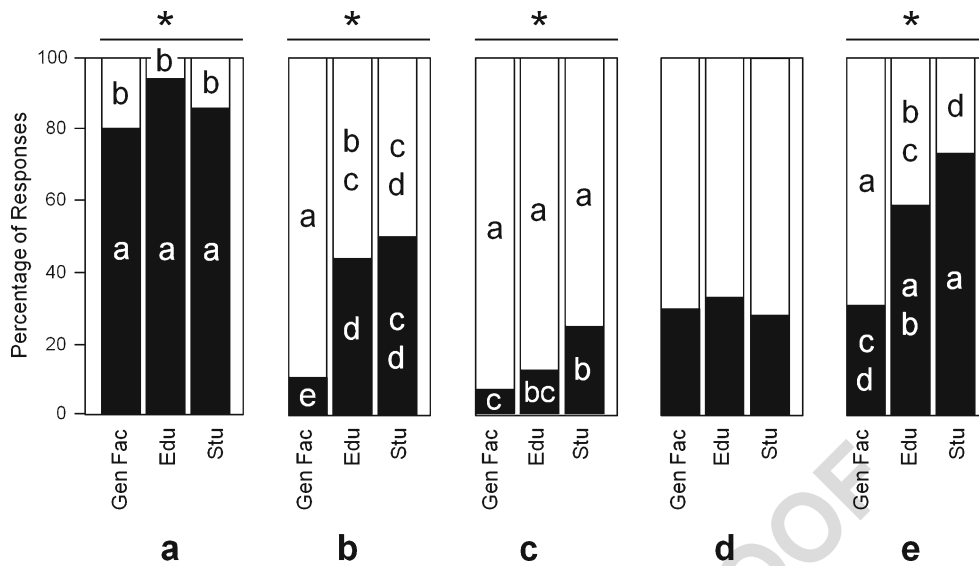


Fig. 8 Percentage of New England general faculty (*Gen Fac*), educators of prospective teachers (*Edu*), and college students (*Stu*) who consider the following definitions of evolution to be either true (*black part of the bar*) or false (*white part of the bar*): *a* gradual process by which the universe changes, it includes the origin of life, its diversification and the synergistic phenomena resulting from the interaction between life and the environment; *b* directional process by which unicellular organisms, like bacteria, turn into multi cellular organisms, like sponges, which later turn into fish, amphibians, reptiles, birds, mammals and ultimately humans, the pinnacle of evolution; *c* gradual process by which monkeys, such as chimpanzees, turn into humans; *d* random process by which life originates,

changes, and ends accidentally in complex organisms such as humans; and *e* gradual process by which organisms acquire traits during their lifetimes, such as longer necks, larger brains, resistance to parasites, and then pass on these traits to their descendants. Comparisons within groups (*asterisks* indicate significance): *a* chi-square=8.532, *df*=2, *P*=0.014; *b* chi-square=36.748, *df*=2, *P*≤0.001; *c* chi-square=14.755, *df*=2, *P*≤0.001; *d* chi-square=0.655, *df*=2, *P*=0.721; *e* chi-square=40.081, *df*=2, *P*≤0.001. Lowercase letters indicate sign test two-tail pair-wise comparisons within groups *P*≤0.05. *Gen Fac*, *n*=221; *Edu*, *n*=53; and *Stu*, *n*=733

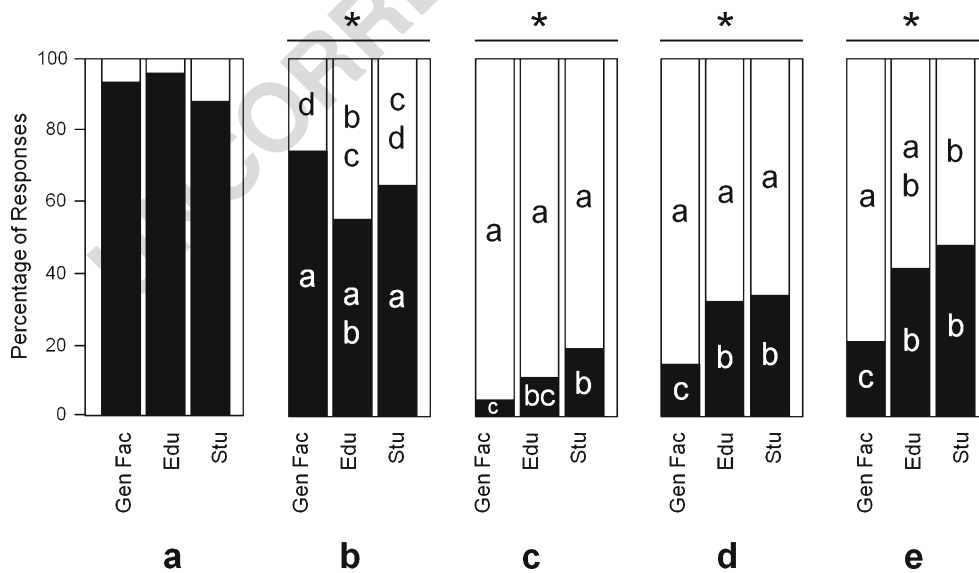


Fig. 9 Percentage of New England general faculty (*Gen Fac*), educators of prospective teachers (*Edu*), and college students (*Stu*) who consider the following statements about evolution to be either true (*black part of the bar*) or false (*white part of the bar*): *a* all current living organisms are descendants of common ancestors, which have evolved for thousands, millions, or billions of years; *b* humans are apes, relatives of chimpanzees, bonobos, gorillas, and orangutans; *c* the hominid (human lineage) fossil record is so poor that scientists cannot tell with confidence that modern humans evolved from ancestral forms;

d the origin of the human mind and consciousness cannot be explained by evolution; and *e* the universe, our solar system and planet Earth are finely tuned to embrace human life. Comparisons within groups (*asterisks* indicate significance): *a* chi-square=5.101, *df*=2, *P*=0.078; *b* chi-square=7.907, *df*=2, *P*=0.019; *c* chi-square=11.212, *df*=2, *P*=0.004; *d* chi-square=11.714, *df*=2, *P*=0.003; *e* chi-square=16.392, *df*=2, *P*≤0.001. Lowercase letters indicate sign test two-tail pair-wise comparisons within groups *P*≤0.05. *Gen Fac*, *n*=221; *Edu*, *n*=53; and *Stu*, *n*=583

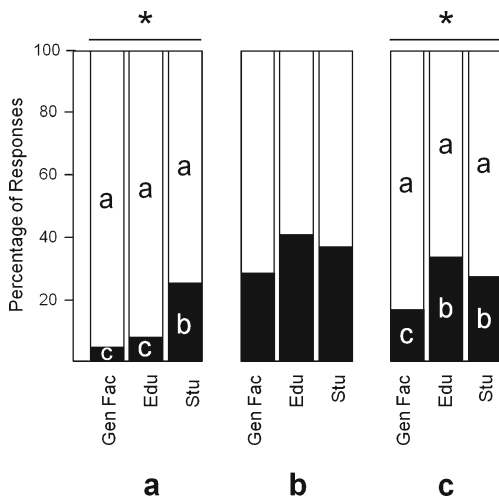


Fig. 10 Percentage of New England general faculty (*Gen Fac*), educators of prospective teachers (*Edu*), and college students (*Stu*) who consider the following statements about religiosity to be either true (black part of the bar) or false (white part of the bar): a faith in God is necessary for morality; b religion is very important in my life; and c I pray at least once a day. Comparisons within groups (asterisks indicate significance): a chi-square=21.033, $df=2$, $P\leq 0.001$; b chi-square=3.733, $df=2$, $P=0.155$; c chi-square=7.644, $df=2$, $P=0.022$. Lowercase letters indicate sign test two-tail pair-wise comparisons within groups $P\leq 0.05$. *Gen Fac*, $n=221$; *Edu*, $n=53$; and *Stu*, $n=587$

729 *Evolution and Responders' Reaction to it* The general
 730 faculty, educators of prospective teachers, and students had
 731 distinctive positions about evolution (Fig. 3; chi-square=
 732 18.538, $df=2$, $P\leq 0.001$): 96.6% of the general faculty,
 733 81.4% of the educators of prospective teachers and 76.4%
 734 of the students thought that hearing about evolution makes
 735 them appreciate the factual explanation about the origin of
 736 life on Earth and its place in the universe; educators of
 737 prospective teachers had intermediate percentile level of
 738 agreement with this position between the general faculty
 739 (high) and the students (low), but the three groups were
 740 statistically similar (sign test two-tail pair-wise comparison
 741 $P\leq 0.05$; Fig. 3). Although only 3.4% of the general faculty
 742 considered that hearing about evolution makes no difference
 743 because evolution and creationism are in harmony, at least
 744 one in five educators of prospective teachers (18.6%) and
 745 one in four students (23.6%) hold this position (Fig. 3). Note
 746 that concerning the “harmony” option the views of the
 747 educators of prospective teachers were statistically similar
 748 to the students’ and these two groups differed from the
 749 general faculty (sign test two-tail pair-wise comparison
 750 $P\leq 0.05$; Fig. 3).

751 *Position about the Teaching of Human Evolution* The
 752 general faculty, educators of prospective teachers, and stu-
 753 dents agreed on their views about the teaching of human
 754 evolution (Fig. 4; chi-square=3.931, $df=2$, $P=0.14$): 98.8%
 755 of the general faculty, 96.6% of the educators of prospective
 756 teachers, and 93.7% of the students preferred science

courses where evolution is discussed comprehensively and
 humans are part of it, and only 1.2% of the general faculty,
 3.4% of the educators of prospective teachers, and 6.3% of
 the students preferred evolution discussions about plants
 and animals but not humans. In each case (i.e., science
 courses including or excluding human evolution) the gener-
 al faculty, educators of prospective teachers and student
 responses were statistically similar (sign test two-tail pair-
 wise comparisons $P\geq 0.05$; Fig 4).

Evolution in Science Exams The general faculty, educators
 of prospective teachers, and students shared opinions about
 the inclusion of evolution in science exams (Fig. 5; chi-
 square=1.34, $df=2$, $P=0.512$): 79.4% of the general faculty,
 72.4% of the educators of prospective teachers, and 75.6%
 of the students had no problem with either instructors in-
 cluding questions concerning evolution in exams or answer-
 ing questions concerning evolution in exams, respectively,
 and 20.6% of the general faculty, 27.6% of the educators of
 prospective teachers, and 24.4% of the students considered
 that exams should always include some questions concern-
 ing evolution. In each case (i.e., optional or required
 inclusion of questions about evolution in exams) the general
 faculty, educators of prospective teachers and student
 responses were statistically similar (sign test two-tail pair-wise
 comparisons $P\geq 0.05$, Fig. 5).

Willingness to Discuss Evolution The general faculty, edu-
 cators of prospective teachers and students differed in their
 willingness to offer opinions about evolution (Fig. 6; chi-
 square=28.022, $df=4$, $P\leq 0.001$): 94.4% of the general fac-
 ulty versus 75.0% of the educators of prospective teachers
 versus 63.4% of the students indicated to accept evolution
 and express it openly regardless of others’ opinions, 2.8%
 of the general faculty versus 12.5% of the educators of pro-
 spective teachers versus 20.0% of the students preferred not
 to comment on this issue, and 2.8% of the general faculty
 versus 12.5% of the educators of prospective teachers versus
 16.6% of the students admitted to accept evolution but not
 discuss it openly to avoid conflicts with friends and family.
 Educators of prospective teachers had intermediate percen-
 tile levels of support for each of these three positions
 between the general faculty and the students and were
 statistically similar to the students in each choice. Educators
 and general faculty were statistically similar in respect to the
 option “acceptance of evolution openly,” but differed in
 respect to the “no opinion” and “acceptance of evolution
 privately” options; note that the general faculty differed
 statistically from the students in all cases (sign test two-tail
 pair-wise comparison $P\leq 0.05$; Fig. 6).

Overall Opinion about Evolution The general faculty, edu-
 cators of prospective teachers and students differed in their

807 overall opinion about evolution (Fig. 7; chi-square=13.835,
 808 $df=2$, $P\leq 0.001$): 81.9% of the general faculty versus 71.4%
 809 of the educators of prospective teachers versus 58.4% of the
 810 students thought that evolution is definitely true, and 18.1%
 811 of the general faculty versus 28.6% of the educators of
 812 prospective teachers versus 41.6% of the students thought
 813 that evolution is probably true. Educators of prospective
 814 teachers had intermediate percentile level of support for
 815 each of these two positions between the general faculty
 816 and the students, but were statistically similar to both
 817 groups; only the general faculty differed statistically from
 818 the students (sign test two-tail pair-wise comparison $P\leq$
 820 0.05; Fig. 7).

821 Views about the Evolutionary Process

822 *An Acceptable Definition of Evolution* There was noticeable
 823 variation in the views of the general faculty versus the
 824 educators of prospective teachers versus the students about
 825 alternative definitions of evolution (Fig. 8): 80% of the
 826 general faculty, 94.3% of the educators of prospective teachers,
 827 and 85.1% of the students considered definition a of evolution
 828 as true: *gradual process by which the universe changes, it*
 829 *includes the origin of life, its diversification and the synergistic*
 830 *phenomena resulting from the interaction between life and the*
 831 *environment*; faculty and student responses were statistically
 832 similar (within group comparisons chi-square=8.532, $df=2$,
 833 $P=0.014$); note that definition a was the most comprehensive
 834 included in the survey. Eleven percent of the general faculty
 835 versus 39.6% of the educators of prospective teachers versus
 836 50.3% of the students considered definition b of evolution as
 837 true: *directional process by which unicellular organisms, like*
 838 *bacteria, turn into multicellular organisms, like sponges,*
 839 *which later turn into fish, amphibians, reptiles, birds, mam-*
 840 *mals and ultimately humans, the pinnacle of evolution* (within
 841 group comparisons chi-square=36.748, $df=2$, $P\leq 0.001$); the
 842 general faculty and the educators of prospective teachers
 843 correctly rejected this definition, but their responses were
 844 significantly different from each other (89% of the general
 845 faculty versus 60.4% considered it false, sign test two-tail
 846 pair-wise comparison $P\leq 0.05$; Fig. 8); despite the 39.6% true
 847 versus 60.4% false responses by the educators of prospective
 848 teachers, their views did not differ statistically from the stu-
 849 dents', but the students true versus false responses were similar
 850 to chance (sign test two-tail pair-wise comparisons $P\geq 0.05$;
 851 Fig. 8); note that definition b implies purpose in evolution and
 852 goal toward "humanity." Six percent of the general faculty
 853 versus 13.2% of the educators of prospective teachers versus
 854 25.3% of the students considered definition c of evolution as
 855 true: *gradual process by which monkeys, such as chimpanzees,*
 856 *turn into humans* (within group comparisons chi-square=
 857 14.755, $df=2$, $P\leq 0.001$); the three groups correctly rejected
 858 this definition (94% of the general faculty, 86.8% of the

859 educators of prospective teachers and 74.% of the students
 860 considered it false, sign test two-tail pair-wise comparison
 861 $P\leq 0.05$; Fig. 8); note that definition c asserts that chimpanzees
 862 are "monkeys" and that humans evolved from them. Thirty
 863 percent of the general faculty, 34.0% of the educators of
 864 prospective teachers and 28.5% of the students considered
 865 definition d of evolution as true: *random process by which life*
 866 *originates, changes, and ends accidentally in complex organ-*
 867 *isms such as humans*; the three groups correctly rejected this
 868 definition (70% of the general faculty, 66% of the educators of
 869 prospective teachers, and 71.5% of the students considered it
 870 false) and their responses were statistically similar (within
 871 group comparisons chi-square=0.655, $df=2$, $P=0.721$); note
 872 that definition d implies that evolution is random and acciden-
 873 tal. Thirty-one percent of the general faculty versus 58.5% of
 874 the educators of prospective teachers versus 74.8% of the
 875 students considered definition e of evolution as true: *gradual*
 876 *process by which organisms acquire traits during their life-*
 877 *times, such as longer necks, larger brains, resistance to para-*
 878 *sites, and then pass on these traits to their descendants* (within
 879 group comparisons chi-square=40.081, $df=2$, $P\leq 0.001$); 69%
 880 of the general faculty versus 41.5% of the educators of pro-
 881 spective teachers versus 25.2% of the students correctly
 882 rejected this Lamarckian definition; note that the general
 883 faculty, educators of prospective teachers and students true/
 884 false responses were distinctive (Gen Fac 31/69% versus Edu
 885 58.5/41.5% versus Stu 74.8/25.2%), however, the views of the
 886 general faculty differed statistically from both the opinions of
 887 the educators of prospective teachers and the students,' the
 888 latter two groups were statistically similar (sign test two-tail
 889 pair-wise comparisons $P\leq 0.05$; Fig. 8).

890 *Evidence about the Evolutionary Process* The general fac-
 891 ulty, educators of prospective teachers and students varied in
 892 their understanding of how evolution works (Fig. 9): 94% of
 893 the general faculty, 96.2% of the educators of prospective
 894 teachers, and 88.2% of the students correctly considered
 895 statement a as true: *all current living organisms are*
 896 *descendants of common ancestors, which have evolved for*
 897 *thousands, millions or billions of years*; responses by the
 898 three groups were statistically similar (within group compar-
 899 isons chi-square=5.101, $df=2$, $P=0.078$). Seventy-four per-
 900 cent of the general faculty versus 54.7% of the educators of
 901 prospective teachers versus 65.4% of the students correctly
 902 considered statement b as true: *humans are apes, relatives of*
 903 *chimpanzees, bonobos, gorillas, and orangutans*; true/false
 904 responses by the three groups differed distinctively (within
 905 group comparisons chi-square=7.907, $df=2$, $P=0.019$) and
 906 although the general faculty and students true versus false
 907 responses were comparable to each other and both were
 908 different than chance (sign test two-tail pair-wise compari-
 909 son $P\leq 0.05$; Fig. 9), the educators of prospective teachers
 910 true versus false responses were similar to chance (sign test

911 two-tail pair-wise comparison $P \geq 0.05$; Fig. 9). Four percent
 912 of the general faculty versus 11.3% of the educators of
 913 prospective teachers versus 18.7% of the students consid-
 914 ered statement c as true: *the hominid (human lineage) fossil*
 915 *record is so poor that scientists cannot tell with confidence*
 916 *that modern humans evolved from ancestral forms* (within
 917 group comparison chi-square=11.212, $df=2$, $P=0.004$);
 918 educators of prospective teachers' responses were statisti-
 919 cally similar to both the general faculty and the students,
 920 however, significantly less general faculty than students
 921 thought that this statement was true (sign test two-tail pair-
 922 wise comparisons $P \leq 0.05$; Fig. 9); note that 96% of the
 923 general faculty, 88.7% of the educators of prospective teach-
 924 ers, and 81.3% of the students correctly rejected this state-
 925 ment and these responses were statistically similar (sign test
 926 two-tail pair-wise comparisons $P \geq 0.05$; Fig. 9). Fifteen
 927 percent of the general faculty versus 32.0% of the educators
 928 of prospective teachers versus 34.7% of the students consid-
 929 ered statement d as true: *the origin of the human mind*
 930 *and consciousness cannot be explained by evolution* (within
 931 group comparison chi-square=11.714, $df=2$, $P=0.003$); the
 932 general faculty responses were statistically different from
 933 both the educators of prospective teachers and the students
 934 (sign test two-tail pair-wise comparisons $P \leq 0.05$; Fig. 9);
 935 note that 85% of the general faculty, 68% of the educators of
 936 prospective teachers, and 65.3% of the students correctly
 937 rejected this statement and their responses were statistically
 938 similar (sign test two-tail pair-wise comparisons $P \geq 0.05$;
 939 Fig. 9). Twenty-one percent of the general faculty versus
 940 41.5% of the educators of prospective teachers versus
 941 47.3% of the students considered statement e as true: *the*
 942 *universe, our solar system and planet Earth are finely tuned*
 943 *to embrace human life* (within group comparisons chi-
 944 square=16.392, $df=2$, $P \leq 0.001$); significantly less general
 945 faculty than both educators of prospective teachers and
 946 students thought that this statement was true (sign test
 947 two-tail pair-wise comparisons $P \leq 0.05$; Fig. 9); although
 948 79% of the general faculty and 58.5% of the educators of
 949 prospective teachers correctly rejected this statement, and
 950 their responses were comparable to each other but different
 951 than chance (sign test two-tail pair-wise comparison $P \leq$
 952 0.05 ; Fig. 9), the students true versus false responses were
 953 similar to chance (sign test two-tail pair-wise comparison
 954 $P \geq 0.05$; Fig. 9).

956 Responders' Religiosity

957 *Your Religiosity* The general faculty, educators of prospective
 958 teachers and students varied in their religiosity (Fig. 10): 5% of
 959 the general faculty, 7.5% of the educators of prospective teach-
 960 ers, and 25.1% of the students considered statement a as true:
 961 *faith in God is necessary for morality* (within group compar-
 962 isons chi-square=21.033, $df=2$, $P \leq 0.001$); significantly less

general faculty and educators of prospective teachers than 963
 students thought that this statement was true (sign test two- 964
 tail pair-wise comparisons $P \leq 0.05$; Fig. 10); note that 95% of 965
 the general faculty, 92.5% of the educators of prospective 966
 teachers, and 74.9% of the students considered this statement 967
 as false and their responses were statistically similar (sign test 968
 two-tail pair-wise comparisons $P \geq 0.05$; Fig. 10). Twenty-nine 969
 percent of the general faculty, 41.5% of the educators of 970
 prospective teachers, and 37.3% of the students considered 971
 statement b as true: *religion is very important in my life* (within 972
 group comparisons chi-square=3.733, $df=2$, $P=0.155$;
 Fig. 10); note that 71% of the general faculty, 59.5% of the 973
 educators of prospective teachers, and 62.7% of the students 974
 thought that this statement was false; true/false responses by 975
 the three groups were statistically similar (sign test two-tail 976
 pair-wise comparisons $P \geq 0.05$; Fig. 10). Seventeen percent of 977
 the general faculty, 34.0% of the educators of prospective 978
 teachers, and 27.6% of the students considered statement c as 979
 true: *I pray at least once a day* (within group comparisons chi- 980
 square=7.644, $df=2$, $P=0.022$; Fig. 10); the general faculty 981
 responses were statistically different from both the educators of 982
 prospective teachers and the students (sign test two-tail pair- 983
 wise comparisons $P \leq 0.05$; Fig. 10); note that 83% of the 984
 general faculty, 66% of the educators of prospective teachers, 985
 and 72.4% of the students rejected this statement and these 986
 responses were statistically similar (sign test two-tail pair-wise 987
 comparisons $P \geq 0.05$; Fig. 10). 988
 989

Understanding of Science, Evolution, and Religiosity Indexes 991

Understanding of Science Index The general faculty, edu- 992
 cators of prospective teachers, and students differed in their 993
 levels of understanding science: the educators of prospective 994
 teachers had intermediate levels of understanding science 995
 (Edu SI=1.96) between the general faculty (Gen Fac SI= 996
 2.49) and the students (Stu SI=1.80; Fig. 11; Kruskal- 997
 Wallis one-way ANOVA on ranks, $H=89.365$, $df=2$, $P \leq$ 998
 0.001); note that the general faculty SI was statistically 999
 different from both the educators of prospective teachers 1000
 SI and the students SI (Dunn test, two-tail pair-wise com- 1001
 parisons $P \leq 0.05$; Fig. 11) and that the latter two groups 1002
 were statistically similar. The three groups responded dis- 1003
 tinctively to each of the subcomponents of choice a question 1004
 10 (above), as follows: first subcomponent (*scientific theo-* 1005
ries are based on opinions by scientists) the partial scores 1006
 were: Gen Fac=0.891, Edu=0.735, and Stu=0.642; second 1007
 subcomponent (*scientific arguments are as valid and re-* 1008
spectable as their non-scientific counterparts) the partial 1009
 scores were: Gen Fac=0.806, Edu=0.641, and Stu=0.635; 1010
 and third subcomponent (*crime-scene and accident-scene* 1011
investigators use a different type of scientific method to 1012
investigate a crime or an accident) the partial scores were: 1013
 Gen Fac=0.792, Edu=0.584, and Stu=0.526. 1014

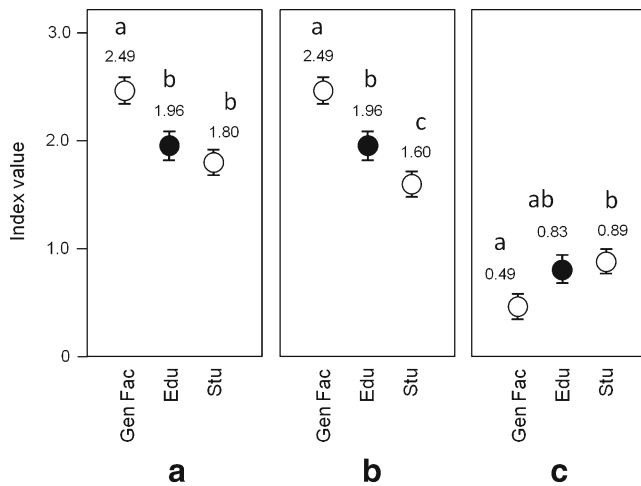


Fig. 11 Understanding of science, evolution, and religiosity indexes of New England general faculty (*Gen Fac*, white circles, left), educators of prospective teachers (*Edu*, black circles, center), and college students (*Stu*, white circles, right). Each index ranges from 0 to 3 (lower to higher levels of understanding of science and evolution, or least to most religious position) as follows: *a* for the *understanding-of-science index*, responders received +1 if they rejected the idea that *scientific theories are based on opinions by scientists*, +1 if they disagreed with the notion that *scientific arguments are as valid and respectable as their nonscientific counterparts*, and +1 if they rejected the statement that *crime-scene and accident-scene investigators use a different type of scientific method to investigate a crime or an accident*; Kruskal–Wallis one-way ANOVA on ranks, $H=89.365$, $df=2$, $P\leq 0.001$. *b* The *evolution index*, responders received +1 if they rejected the idea that *organisms acquire beneficial traits during their lifetimes and then pass on these traits to their descendants*, +1 if they disagreed with the notion that *during evolution monkeys such as chimpanzees can turn into humans*, and +1 if they rejected the statement that *the origin of the human mind and consciousness cannot be explained by evolution*; Kruskal–Wallis one-way ANOVA on ranks, $H=171.683$, $df=2$, $P\leq 0.001$. *c* The *religiosity index*, responders received +1 if they agreed with the idea that *faith in God is necessary for morality*, +1 if they accepted the statement that *religion is very important in their lives*, and +1 if they admitted to *pray daily*; Kruskal–Wallis one-way ANOVA on ranks, $H=21.734$, $df=2$, $P\leq 0.001$. Lowercase letters indicate Dunn-test two-tail pair-wise comparisons within groups $P\leq 0.05$. *Gen Fac*, $n=222$; *Edu*, $n=53$; and *Stu*, $n=576$. Error bars are standard errors

1015 **Understanding of Evolution Index** The general faculty, edu-
 1016 cators of prospective teachers, and students differed distinc-
 1017 tively in their levels of understanding evolution: the
 1018 educators of prospective teachers had intermediate levels
 1019 of understanding evolution (*Edu EI*=1.96) between the gen-
 1020 eral faculty (*Gen Fac EI*=2.49) and the students (*Stu EI*=
 1021 1.60; Fig. 11; Kruskal–Wallis one-way ANOVA on ranks,
 1022 $H=171.683$, $df=2$, $P\leq 0.001$); note that each of these three
 1023 groups were statistically different (Dunn test, two-tail pair-
 1024 wise comparisons $P\leq 0.05$; Fig. 11). The three groups
 1025 responded distinctively to each of the subcomponents of
 1026 choice b question 10 (above), as follows: first subcomponent
 1027 (*organisms acquire beneficial traits during their lifetimes and*
 1028 *then pass on these traits to their descendants*) the partial
 1029 scores were: *Gen Fac*=0.689, *Edu*=0.415, and *Stu*=0.230;

second subcomponent (*during evolution monkeys such as*
 chimpanzees can turn into humans) the partial scores were:
Gen Fac=0.950, *Edu*=0.867, and *Stu*=0.725; and third sub-
 component (*the origin of the human mind and consciousness*
 cannot be explained by evolution) the partial scores were: *Gen*
Fac=0.851, *Edu*=0.679, and *Stu*=0.642.

Religiosity Index The general faculty, educators of prospec-
 tive teachers, and students differed in their levels of religi-
 osity: the educators of prospective teachers had intermediate
 levels of religiosity (*Edu RI*=0.83) between the general
 faculty (*Gen Fac RI*=0.49) and the students (*Stu RI*=0.89;
 Fig. 11; Kruskal–Wallis one-way ANOVA on ranks, $H=$
 21.734 , $df=2$, $P\leq 0.001$), but only the general faculty *RI*
 differed statistically from the students *RI* (Dunn test two-tail
 pair-wise comparisons $P\leq 0.05$; Fig. 11). The three groups
 responded distinctively to each of the subcomponents of
 choice c in question 10 (above), as follows: first subcompo-
 nent (*faith in God is necessary for morality*) the partial
 scores were: *Gen Fac*=0.045, *Edu*=0.075, and *Stu*=0.246;
 second subcomponent (*religion is very important in my life*)
 the partial scores were: *Gen Fac*=0.283, *Edu*=0.415, and
Stu=0.372; and third subcomponent (*I pray at least once a*
day) the partial scores were: *Gen Fac*=0.166, *Edu*=0.339,
 and *Stu*=0.267.

Associations between Indexes The three groups showed
 directionality in the association between indexes (Fig. 12).
 Levels of understanding of science and evolution by the
 general faculty, educators of prospective teachers, and
 students decreased with increasing religiosity (=negative
 association of variables); in contrast, levels of understanding
 of evolution increased with increasing understanding of
 science (=positive association of variables). The scale at
 which the *SI* and *EI* indexes decreased as function of
 increasing *RI* was in accordance with the high levels of
 understanding of science/evolution, and low religiosity, by
 the general faculty in respect to the intermediate and low
 levels of understanding of science/evolution, and high
 religiosity, by the educators of prospective teachers and
 the students, respectively (first and second rows, Fig. 12);
 analogously, the scale at which the *EI* index increased as
 function of *SI* was in accordance with the high understand-
 ing of science/evolution by the general faculty and the
 intermediate and low levels of understanding of science by
 the educators of prospective teachers and the students,
 respectively (third row, Fig. 12). Note the following pattern
 in Fig. 12: in the context of *SI* versus *RI* comparisons, the
 highest to lowest levels of understanding of science by the
 general faculty (*Gen Fac SI*=2.59–2.0; 69.8–3.2% of res-
 ponders; index $R^2=0.964$, $P=0.009$; Fig. 12a), educators of
 prospective teachers (*Edu SI*=2.07–1.0; 52.8–7.5% of res-
 ponders; index $R^2=0.740$, $P=0.069$; Fig. 12b), and students

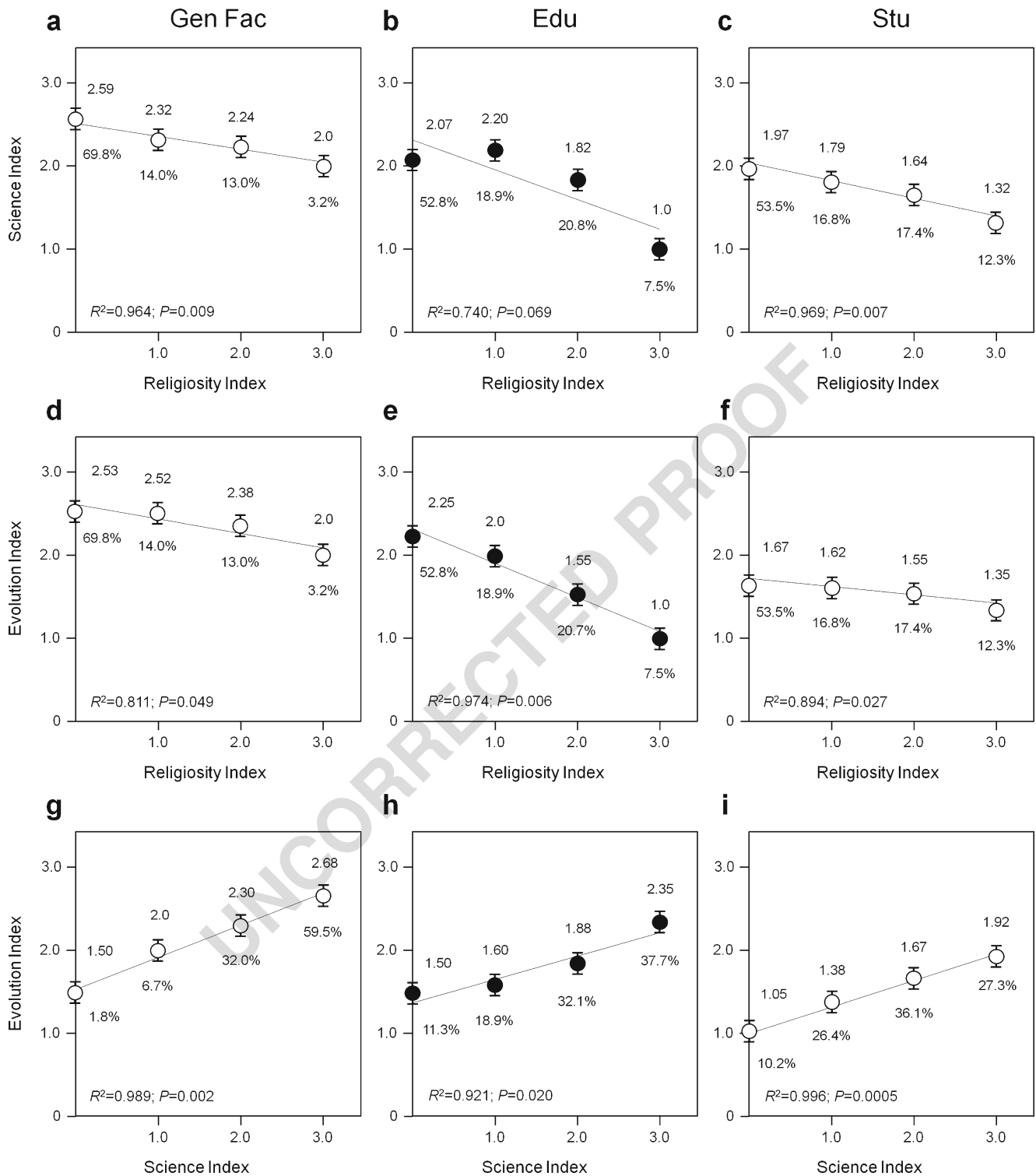


Fig. 12 Association between understanding of science, evolution, and religiosity indexes of New England general faculty (*Gen Fac*, white circles, left), educators of prospective teachers (*Edu*, black circles, center) and college students (*Stu*, white circles, right). The linear regressions depict the association between the 0-to-3 levels of: first row, *science index* versus *religiosity index*; second row, *evolution index* versus *religiosity index*; and third row, *evolution index* versus *science index* for each of the subpopulations of responders (i.e., *Gen Fac*: a, d, g; *Edu*: b, e, h; and *Stu*: c, f, i); the inverse association between level of understanding of science/

evolution and level of religiosity (first and second rows), as well as the direct association between level of understanding of evolution and level of understanding of science (third row) are evident. Numbers above and below regression lines correspond to index values and percent of responders per data point, respectively. Linear regressions one tail: a, $R^2=0.964$, $P=0.009$; b, $R^2=0.740$, $P=0.069$; c, $R^2=0.969$, $P=0.007$; d, $R^2=0.811$, $P=0.049$; e, $R^2=0.974$, $P=0.006$; f, $R^2=0.894$, $P=0.027$; g, $R^2=0.989$, $P=0.002$; h, $R^2=0.921$, $P=0.020$; and i, $R^2=0.996$, $P=0.0005$. *Gen Fac*, $n=222$; *Edu*, $n=53$; and *Stu*, $n=576$. Error bars are standard errors

1081 (Stu SI=1.97–1.32; 53.5–12.3% of responders; index $R^2=$
 1082 0.969, $P=0.007$; Fig. 12c) corresponded to the lowest to
 1083 highest levels of religiosity ($RI=0.0$ – 3.0) in each group,
 1084 respectively. In the context of EI versus RI, the highest to
 1085 lowest levels of understanding of evolution by the general
 1086 faculty (Gen Fac EI=2.53–2.0; 69.8–3.2% of responders;
 1087 index $R^2=0.811$, $P=0.049$; Fig. 12d), educators of prospec-
 1088 tive teachers (Edu EI=2.25–1.0; 52.8–7.5% of responders;
 1089 index $R^2=0.974$, $P=0.006$; Fig. 12e), and students (Stu EI=
 1090 1.67–1.35; 53.5–12.3% of responders; index $R^2=0.894$, $P=$
 1091 0.027; Fig. 12f) corresponded to the lowest to highest levels
 1092 of religiosity ($RI=0.0$ – 3.0) in each group, respectively. And,
 1093 in the context of EI versus SI, the lowest to highest levels of
 1094 understanding of evolution by the general faculty (Gen Fac
 1095 EI=1.50–2.68; 1.8–59.5% of responders; index $R^2=0.989$,
 1096 $P=0.002$; Fig. 12g), educators of prospective teachers (Edu
 1097 EI=1.50–2.35; 11.3–37.7% of responders; index $R^2=0.921$,
 1098 $P=0.020$; Fig. 12h), and students (Stu EI=1.05–1.92; 10.2–
 1099 27.3% of responders; index $R^2=0.996$, $P=0.0005$; Fig. 12i)
 1100 corresponded to the lowest to highest levels of understanding
 1102 of science ($SI=0.0$ to 3.0) in each group, respectively.

1103 **Discussion**

1104 To facilitate the discussion of the data, below we round up
 1105 the values and discuss them in the context of generalizations
 1106 and broad patterns:

1107 **Views about Evolution, Creationism, and ID**

1108 The educators of prospective teachers consistently held
 1109 intermediate positions about evolution, creationism and
 1110 intelligent design in respect to the general faculty and the
 1111 students, as follows: 96% of the general faculty versus 86%
 1112 of the educators of prospective teachers versus 71% of the
 1113 students supported the exclusive teaching of evolution in
 1114 science classes, and only 4% of the general faculty versus
 1115 14% of the educators of prospective teachers versus 29% of
 1116 the students favored equal time to evolution, creationism
 1117 and intelligent design (Fig. 1); 92% of the general faculty
 1118 versus 82% of the educators of prospective teachers versus
 1119 50% of the students perceived ID as either not scientific and
 1120 proposed to counter evolution based on false claims or as
 1121 religious doctrine consistent with creationism (combined
 1122 values choices a+b, Fig. 2). Only 8% of the general faculty
 1123 versus 18% of the educators of prospective teachers versus
 1124 40% of the students had either no opinion about ID, consid-
 1125 ered it a scientific alternative to evolution and of equal
 1126 scientific validity among scientists, or thought of ID as a
 1127 scientific theory about the origin of life on Earth (combined
 1128 values choices c+d+e, Fig. 2). Although the general faculty
 1129 and the educators of prospective teachers had a clearer

1130 understanding of ID than the students (Gen Fac and Edu 1130
 1131 were statistically similar; Fig. 2), it is of concern that one in 1131
 1132 ten general faculty, one in five educators of prospective 1132
 1133 teachers, and one in two students were unaware of the nature 1133
 1134 of ID or considered it a legitimate scientific proposal. 1134

1135 Most of the general faculty (97%) and many of the 1135
 1136 educators of prospective teachers (81%) and the students 1136
 1137 (76%) preferred factual explanations about the origin of life 1137
 1138 on Earth and its place in the universe (choice a, Fig. 3); 1138
 1139 although only one in 30 general faculty thought that evolu- 1139
 1140 tion and creationism are in harmony, one in five educators of 1140
 1141 prospective teachers, and one in four students favored this 1141
 1142 position (choice b, Fig. 3). Interestingly, 96% of the general 1142
 1143 faculty, educators of prospective teachers, and students pre- 1143
 1144 ferred science courses where evolution is discussed compre- 1144
 1145 hensively and humans are part of it (mean combined values 1145
 1146 choice a, Fig. 4), and 76% of all responders had no problem 1146
 1147 with either instructors including questions concerning evo- 1147
 1148 lution in exams or answering questions concerning evolu- 1148
 1149 tion (mean combined values choice a, Fig. 5); in fact, one in 1149
 1150 every four responders considered that science exams should 1150
 1151 always include some questions concerning evolution 1151
 1152 (choice b, Fig. 5). 1152

1153 Most of the general faculty (94%) and many of the 1153
 1154 educators of prospective teachers (75%) indicated to accept 1154
 1155 evolution and express it openly regardless of others' opin- 1155
 1156 ions; only 63% of the students agreed with this position. 1156
 1157 Although only one in ca. 20 general faculty either did not 1157
 1158 comment on this issue or admitted to accept evolution 1158
 1159 privately (choices b, c, Fig. 6), one in four educators of 1159
 1160 prospective teachers and one in three students held these 1160
 1161 positions. Indeed, educators of prospective teachers hesitat- 1161
 1162 ed to embrace evolution; note that only 71% of them 1162
 1163 thought that evolution is definitely true and 29% considered 1163
 1164 it to be probably true (Fig. 7), placing between the general 1164
 1165 faculty (definitely true 82%; probably true 18%) and the 1165
 1166 students (definitely true 58%; probably true 42%; Fig. 7). 1166

1167 **Views about the Evolutionary Process**

1168 The educators of prospective teachers held an intermediate 1168
 1169 level of understanding of the evolutionary process in respect 1169
 1170 to the general faculty and the students; in some cases, their 1170
 1171 opinions were statistically similar to the students' and dif- 1171
 1172 ferred from those of the general faculty, as follows: 86% 1172
 1173 (mean value) of the general faculty, educators of prospective 1173
 1174 teachers and students agreed with a comprehensive defini- 1174
 1175 tion of evolution as a *gradual process by which the universe*
 1176 *changes, [which] includes the origin of life, its diversifica-*
 1177 *tion and the synergistic phenomena resulting from the inter-*
 1178 *action between life and the environment; and 69% (mean*
 1179 *value) correctly rejected the definition that evolution is a*
 1180 *random process by which life originates, changes, and ends* 1180

1181 *accidentally in complex organisms such as humans* (choices
 1182 a, d, Fig. 8). The general faculty correctly rejected (89%) the
 1183 notion of “purpose” and “goal toward humanity” in evolu-
 1184 tion (choice b, Fig. 8), and also the misconception that
 1185 humans have evolved from chimpanzees (rejection 94%,
 1186 choice c, Fig. 8) or the possibility of Lamarckian inheritance
 1187 of acquired traits (rejection only 69%, choice e, Fig. 8). In
 1188 contrast, only 60%, 87%, and 42% of the educators of
 1189 prospective teachers rejected these statements, respectively
 1190 (choices b, c, e, Fig. 8). Their views were statistically similar
 1191 to the students’ regarding these choices.

1192 The level of understanding of how evolution works varied
 1193 among the general faculty, educators of prospective
 1194 teachers, and students. All agreed that evolution relies on
 1195 common ancestry (93%, mean choice a, Fig. 9) and that
 1196 humans are apes (64%, mean choice b, Fig. 9); however,
 1197 one in four general faculty, one in two educators of prospec-
 1198 tive teachers, and one in three students did not know that
 1199 humans are close relatives to chimpanzees, bonobos, goril-
 1200 las, and orangutans (choice b, Fig. 9). Eighty-nine percent of
 1201 the general faculty, educators of prospective teachers, and
 1202 students (mean values choice c, Fig. 9) knew that the hom-
 1203 inid fossil record is rich enough for scientists to conclude
 1204 that humans have evolved from ancestral forms, but one in
 1205 five general faculty and one in three educators of prospec-
 1206 tive teachers and students (mean) believed, incorrectly, that
 1207 the origin of the human mind cannot be explained by evo-
 1208 lution (choice d, Fig. 9); indeed, one in five general faculty
 1209 and almost half of the educators of prospective teachers and
 1210 students (mean) thought, erroneously, that *the universe, our*
 1211 *solar system and planet Earth are finely tuned to embrace*
 1212 *human life* (choice e, Fig. 9). The latter (=anthropic princi-
 1213 ple; Stenger 2011) is a powerful illusion and a by-product of
 1214 the self-referent human mind engaged in examining the
 1215 cosmos. Moreover, the diversity of successful adaptations
 1216 in nature give the impression that the environment perfectly
 1217 matches them; in reality, it is life that “matches” the always
 1218 changing environments (Paz-y-Miño-C and Espinosa
 1219 2011a).

1220 Responders’ Religiosity

1221 Interestingly, the general faculty, educators of prospective
 1222 teachers, and students showed statistically comparable
 1223 responses in choice b of question 10 (above): ~36% of them
 1224 (mean) considered *religion to be very important in their*
 1225 *lives*. But they differed in choices a and c of question 10:
 1226 one in 16 (mean) educators of prospective teachers and
 1227 general faculty believed that *faith in God is necessary for*
 1228 *morality*, in contrast to one in four students (Fig. 10); and
 1229 one in three (mean) educators of prospective teachers and
 1230 students confessed to *pray daily*, in contrast to one in six
 1231 general faculty (Fig. 10).

1232 Despite the percentile statistical similarity (~36%, above) 1232
 1233 among the general faculty, educators of prospective teach- 1233
 1234 ers, and students who considered *religion [to be] very im-* 1234
 1235 *portant in their lives*, the independent 41.5% agreement 1235
 1236 with this statement by the educators of prospective teachers 1236
 1237 is higher than the 29% by the general faculty (Fig. 10) and 1237
 1238 among the highest reported for Ph.D.-educated audiences. 1238
 1239 For example, 33% of American scientists ($n=2,533$) admit 1239
 1240 to believe in God (The Pew Research Center for the People 1240
 1241 & the Press 2009), in contrast to 12% of “professional 1241
 1242 evolutionary scientists” ($n=149$ members of North American, 1242
 1243 European, UK, and other countries; National Academies of 1243
 1244 Sciences; Graffin and Provine 2007) and 7% of members of 1244
 1245 the U.S. National Academy of Science ($n=260$) who believe 1245
 1246 in a personal God (Larson and Witham 1998). Two studies 1246
 1247 ($n=1,646$, Ecklund and Scheitle 2007; $n=1,417$, Gross and 1247
 1248 Simmons 2009) have documented that ~30% of the American 1248
 1249 professoriate (ca. 630,000 faculty teaching full time at 1249
 1250 colleges and universities) is religious across institutions 1250
 1251 and fields, highlighting that researchers in the natural 1251
 1252 sciences (physics, biology) are less religious than their 1252
 1253 social sciences counterparts (sociology, economics, history, 1253
 1254 except psychology); our sample of educators of prospective 1254
 1255 teachers was indeed highly religious. Responders’ religiosity 1255
 1256 is discussed beyond the percentile description and in more 1256
 1257 depth below, when addressing the RI. 1257

1258 Understanding of Science, Evolution, and Religiosity Indexes 1258

1259 The educators of prospective teachers consistently held in- 1259
 1260 termediate levels of understanding science, the evolutionary 1260
 1261 process, and religiosity in respect to the general faculty and 1261
 1262 the students (Fig. 11), as follows: the general faculty were 1262
 1263 the most knowledgeable about science and evolution and the 1263
 1264 least religious (Gen Fac: SI=2.49, EI=2.49, and RI=0.49; 1264
 1265 Fig. 11); the educators of prospective teachers reached lower 1265
 1266 science and evolution—but higher religiosity—indexes than 1266
 1267 the general faculty (Edu: SI=1.96, EI=1.96, and RI=0.83; 1267
 1268 Fig. 11); and the students were the least knowledgeable 1268
 1269 about science and evolution and the most religious (Stu: 1269
 1270 SI=1.80, EI=1.60, and RI=0.89; Fig. 11). Understanding 1270
 1271 of science and evolution were inversely correlated with level 1271
 1272 of religiosity and understanding of evolution increased with 1272
 1273 increasing science literacy (Fig. 12). The SI, EI, and RI 1273
 1274 index patterns reported here are in accordance with the 1274
 1275 proposal of various scholars (Bishop and Anderson 1990; 1275
 1276 Downie and Barron 2000; Trani 2004; Paz-y-Miño-C and 1276
 1277 Espinosa 2009a, b, 2011a, b; but see Miller et al. 2006; 1277
 1278 Nadelson and Sinatra 2009) that the interaction between 1278
 1279 science/evolution literacy and level of religiosity determine 1279
 1280 an individual’s acceptance of evolution, which is corrobo- 1280
 1281 rated by additional evidence compiled by this study: (1) the 1281
 1282 overall high and open acceptance of evolution by the 1282

1283 general faculty (94%), intermediate by the educators of
 1284 prospective teachers (75%), and low by the students (63%,
 1285 Fig. 6); and (2) the observation that 82% of the general
 1286 faculty (high), 71% of the educators of prospective teachers
 1287 (intermediate), and 58% of the students (low) thought that
 1288 evolution is definitely true (above; Fig. 7).

1289 Various studies have detected inverse correlation between
 1290 religiosity/belief and acceptance of evolution (Miller et al.
 1291 2006; The Gallup Poll 2008, 2009, 2010; Nadelson and
 1292 Sinatra 2009), and a positive association between evolution
 1293 acceptance and scientific literacy, particularly genetics
 1294 (Miller et al. 2006); however, there is discrepancy about
 1295 the association between general educational attainment and
 1296 attitudes toward evolution (Miller et al. 2006; Pigliucci
 1297 2007; Nehm and Schonfeld 2007). It is important to empha-
 1298 size that the religiosity indexes of our samples of general
 1299 faculty and the educators of prospective teachers/students
 1300 were three and ca. two times below the U.S. national score
 1301 RI=1.40, $n=2,026$ (The Pew Global Attitudes Project
 1302 2007), respectively, but that only the New England general
 1303 faculty had a level of religiosity comparable to that of the
 1304 general public in Western Europe, the lowest worldwide
 1305 (The Pew Global Attitudes Project 2007; Paz-y-Miño-C
 1306 and Espinosa 2011a). Our educators of prospective teachers
 1307 sampled here were statistically as religious as the students
 1308 (Fig. 11) and more religious than the Canadian general
 1309 public (RI=0.72; The Pew Global Attitudes Project 2007)
 1310 whose overall acceptance of evolution is 58%, although
 1311 63% of East Coast Canadians accept evolution ($n=1,007$;
 1312 Angus Reid Strategies 2008), which is comparable to 59%
 1313 of their East Coast American counterparts (The Pew
 1314 Research Center for The People & The Press 2005).

1315 Characterizers of acceptance of evolution in the U.S.

1316 Public acceptance of evolution in the U.S. correlates with
 1317 level of education, increasing from the high school (20/
 1318 21%), to the some college (32/41%), college graduate (52/
 1319 53%), post-graduate (65/74%; $n=NA/1,018$; Brumfiel
 1320 2005; The Gallup Poll 2009), and university professor levels
 1321 (97%, Paz-y-Miño-C and Espinosa 2011a, this study;
 1322 choices a+c, Fig. 6). The average acceptance of evolution
 1323 by the U.S. general public is 35–40% (Brumfiel 2005;
 1324 Miller et al. 2006), which coincides with the population
 1325 attaining only some college education (above). Although
 1326 88% (open+private acceptance of evolution; choices a+c,
 1327 Fig. 6) of the New England educators of prospective teach-
 1328 ers sampled in this study accepted evolution, their score was
 1329 below the general faculty (97%, choices a+c, Fig. 6) and
 1330 comparable to the students' (83%, choices a+c, Fig. 6), the
 1331 latter higher than their national counterparts (above). Only
 1332 the U.S. post-graduates and our samples of New England
 1333 college students, educators of prospective teachers, and

1334 general faculty have levels of acceptance of evolution com-
 1335 parable to or higher than the general public in other indus-
 1336 trialized and prosperous nations like Iceland, Denmark,
 1337 Sweden, France, Japan, and the UK ($\approx 75\text{--}85\%$; Miller et al.
 1338 2006; see detailed discussion in Paz-y-Miño-C and Espinosa
 1339 2011a).

1340 Opposition to evolution in the U.S. resides in specific
 1341 variables (Paz-y-Miño-C and Espinosa 2011a, b): religious
 1342 beliefs, pro-life beliefs, and political ideology account for
 1343 most of the variance against evolutionary views (total nine
 1344 independent variables), which differ distinctly between the
 1345 US ($R^2=0.46$ total effects) and Europe ($R^2=0.18$ total
 1346 effects; Miller et al. 2006; Miller and Pennock 2008; see
 1347 The Pew Forum on Religion & Public Life 2008 for detailed
 1348 statistics on the relationship between religious affiliations
 1349 and pro-life beliefs, political ideology, and evolution);
 1350 among U.S. educational professionals, decrease in both
 1351 evolution acceptance and knowledge correlates with
 1352 increase in religious commitment ($n=337$; Nadelson and
 1353 Sinatra 2009); conservative republicans in the U.S. accept
 1354 evolution less than progressive liberals and independents
 1355 (30% versus 60%, respectively, $n=1,007$; The Gallup Poll
 1356 2007); and frequency of religious practices correlates nega-
 1357 tively with acceptance of evolution: 24% among weekly
 1358 churchgoers versus 71% for seldom or never ($n=1,007$;
 1359 The Gallup Poll 2007).

1360 We have previously postulated (Paz-y-Miño-C and Espinosa
 1361 2011a) that if attitudes toward evolution by both the general
 1362 public and highly educated audiences, like university professors
 1363 correlate, ultimately, with understanding of science/evolution
 1364 and religiosity/political ideology (positive and negative associ-
 1365 ation of variables, respectively; data above), it follows that
 1366 robust science education combined with vigorous public
 1367 debate—where scientific knowledge versus popular belief are
 1368 constantly discussed—shall increase acceptance of naturalistic
 1369 rationalism and decrease the negative impact of creationism and
 1370 ID on “*society’s evolution literacy*.” We acknowledge, howev-
 1371 er, that societal interactions between science and ideology are
 1372 complex, multi factorial, variable in a spatiotemporal context,
 1373 and subject to public policy, demographics, law and socio-
 1374 economic change (Lerner 2000; Moore 2002, 2004; Gross et
 1375 al. 2005; Apple 2008; Miller and Pennock 2008; Berkman and
 1376 Plutzer 2009; Ecklund and Park 2009; Padian and Matzke
 1377 2009; Matzke 2010; Wexler 2010; Paz-y-Miño-C and Espinosa
 1378 2011a, b).

1379 Why do the highly trained educators of prospective
 1380 teachers (87% Ph.D./doctorate holders) hesitate to embrace
 1381 evolution or have lower acceptance of evolution than the
 1382 general faculty (93% Ph.D./doctorate holders)? The nega-
 1383 tive feedback among variables reported in this study (i.e.,
 1384 science/evolution versus religiosity), plus the U.S. trends in
 1385 acceptance of evolution as function of academic level
 1386 (above), help us address this question: (1) the higher the

1387 level of understanding science/evolution the lower the level
1388 of religiosity among all responders (Figs. 11 and 12); (2) the
1389 higher the level of understanding of science the higher the
1390 level of understanding of evolution in all groups (Fig. 12);
1391 and (3) the higher the level of education the higher the
1392 acceptance of evolution and the lower the religiosity (com-
1393 piled national data, Brumfiel 2005; The Gallup Poll 2009,
1394 2010; Paz-y-Miño-C and Espinosa 2009a, b, 2011a, this
1395 study). Because we assume that the Ph.D.- or doctoral-
1396 training levels in *pedagogy* (=specialization of the educators
1397 of prospective teachers) or in *other academic fields* (=the
1398 general faculty) are analogously rigorous in the U.S., we
1399 conclude that the hesitation to fully embrace evolution by
1400 the educators of prospective teachers is inherent to their
1401 deficient understanding of science/evolution and high reli-
1402 giosity (Figs. 10, 11, and 12). Although differences in atti-
1403 tudes toward evolution by professors in diverse fields and
1404 geographic regions of the U.S. are conceivable, our sample
1405 of the New England general faculty generated unambiguous
1406 responses (Gen Fac: 94/3% open/private acceptance of
1407 evolution and 3% no opinion) in contrast to the cautious
1408 views held by the educators (Edu: 75/13% open/private
1409 acceptance of evolution and 13% no opinion; Fig. 6).

1410 How can the educators of prospective teachers strengthen
1411 their own literacy in science and evolution and make a signif-
1412 icant impact on the literacy of their “academic progeny,” the
1413 future teachers? We suggest to: (1) Apply *equal rigor* to the
1414 training in pedagogy and science/evolution; the educators of
1415 prospective teachers should reach comparable levels of under-
1416 standing science/evolution and accepting evolution to those of
1417 the general-faculty. There are reputable online courses in
1418 evolution available to all audiences (e.g., [University of](#)
1419 [Arizona](#), see references), and the [National Science Teachers](#)
1420 [Association](#), [National Association of Biology Teachers](#),
1421 [National Science Foundation](#), [Smithsonian National Museum](#)
1422 [of Natural History](#), [The Society for the Study of Evolution](#),
1423 [National Academies of Sciences](#), [American Museum of](#)
1424 [Natural History](#), or the [Understanding Evolution of the](#)
1425 [University of California Berkeley Museum of Paleontology](#)
1426 offer impressive online resources specific for educators
1427 (see links in references). (2) Dialog with the science faculty
1428 at their own institutions and concur to fortify the on-the-job-
1429 science/evolution training of the educators of prospective
1430 teachers, as well as of the students enrolled in education
1431 programs. The ubiquitous disconnect between the education
1432 departments and the rest of the academic fields at the U.S.
1433 colleges and universities is concerning, and it requires imme-
1434 diate approach between the educators and the general faculty
1435 (see Paz-y-Miño-C and Espinosa 2011a). (3) Educate them-
1436 selves about the “antievolution wars” (Ruse 2001; Pigliucci
1437 2007; Berkman and Plutzer 2009; Branch et al. 2010) and
1438 participate decisively in the proteaching-of-evolution move-
1439 ment. In this area of public discourse, our sample of educators

1440 of prospective teachers also placed below the standards held by
1441 the general faculty: 85% of the educators of prospective teach-
1442 ers versus 91% of the general faculty were very concerned
1443 (Edu 44% versus Gen Fac 64%) or somehow concerned (Edu
1444 41% versus Gen Fac 27%) about the controversy over evolu-
1445 tion versus creationism versus ID and its implications for
1446 science education (data, this study). It is crucial that the edu-
1447 cators of prospective teachers lead the institutional (their own
1448 colleges and universities), regional and national strategies to
1449 secure proper science/evolution education among the prospec-
1450 tive teachers who earn degrees under their guidance. As uni-
1451 versity professors, the educators of prospective teachers are
1452 less vulnerable to institutional or societal reprisal for leading
1453 the teaching of evolution than their academic progeny of
1454 young teachers; note that 43% of school instructors are willing
1455 to dedicate “equal time” to science and ID (National Science
1456 Foundation 2006) and 30% admit have been pushed to de-
1457 emphasize or omit evolution or evolution-related topics from
1458 their curriculum due to pressure coming from students and
1459 parents (National Science Teachers Association 2005). The
1460 educators of future educators are as responsible for sponsoring
1461 proper science/evolution training to the prospective teachers as
1462 the latter are of acquiring and communicating that knowledge
1463 to their students. (4) Study the legal protection that guarantees
1464 proper science/evolution education at all academic levels and
1465 make this information available to the prospective teachers as
1466 part of their regular training. The [National Center for Science](#)
1467 [Education](#) maintains a comprehensive website (see references)
1468 with *information and resources for schools, parents and*
1469 *concerned citizens working to keep evolution in public school*
1470 *science education* (see also Moore 2004); its link “taking
1471 action” is particularly valuable for educators of future educa-
1472 tors and the prospective teachers they mentor. (5) Implement
1473 curricular reform at their education departments and institu-
1474 tions to fortify science training of prospective teachers. Higher-
1475 education programs in science, particularly biology, are funda-
1476 mental to integrate evolution into the academic backgrounds of
1477 prospective teachers (Paz-y-Miño-C and Espinosa 2009a, b,
1478 2011a). Note that school teachers in the U.S. rely on poor to
1479 excellent evolution state education standards that guide their
1480 teaching practices (Mead and Mates 2009; for a historical
1481 account of this type of assessments, see Moore 2002; Lerner
1482 2000, 2006) and that when unprepared in science/evolution
1483 their personal opinions influence the quality of schooling more
1484 than states’ guidelines: 14–69% of school teachers ($n=15$
1485 states in the U.S.) question or reject evolution and teach
1486 supernatural causation (Moore 2002), and 13% explicitly ad-
1487 vocate creationism and ID in classes (Berkman and Plutzer
1488 2011). (6) Poll in-campus variations in attitudes toward science
1489 and evolution among the educators of future educators, the
1490 prospective teachers they mentor, and the general faculty, and
1491 coordinate immediate responses to the emerging antievolution-
1492 ism in the U.S. campuses (Paz-y-Miño-C and Espinosa 2011a;

1493 see [Evolution Literacy University of Massachusetts Dartmouth](#)
 1494 in references). Contrary to the assumption that skepticism
 1495 toward creationists views predominates in academia, this study
 1496 and others (Ecklund and Scheitle 2007; Gross and Simmons
 1497 2009; Ecklund and Long 2011; Paz-y-Miño-C and Espinosa
 1498 2011a) demonstrate that the U.S. university professors, even at
 1499 prestigious research institutions, increasingly admit to embrace
 1500 religiosity, a factor negatively correlated with acceptance of
 1501 evolution (Miller et al. 2006; The Gallup Poll 2007, 2008,
 1502 2009, 2010; Nadelson and Sinatra 2009; this study); it is,
 1503 therefore, conceivable to forecast a decline in acceptance of
 1504 evolution by all faculty (Paz-y-Miño-C and Espinosa 2011a),
 1505 and particularly by the educators of prospective teachers whose
 1506 religiosity is high (this study), but these predictions need
 1507 longitudinal verification. (7) Cosponsor with the general
 1508 faculty in- and off- campus lecture series, workshops and
 1509 debates to examine the antievolution phenomena, learn about
 1510 the obstacles raised by schools boards on the science school
 1511 curriculum and orient other educators of future educators and
 1512 prospective teachers on how to communicate modern science
 1513 to all (Paz-y-Miño-C and Espinosa 2009b, 2011a). Workshop-
 1514 discussion modules on *why evolution matters* can be particu-
 1515 larly effective when organized for educators of future educa-
 1516 tors and prospective teachers (see exemplar case in Johnson et
 1517 al 2009). (8) Pursue participation in and organization of “*town*
 1518 *halls for educators of prospective teachers*” to discuss issues
 1519 related to the controversy evolution versus creationism versus
 1520 ID (similar to Paz-y-Miño-C and Espinosa 2011a). Surprising-
 1521 ly, only 24% of the U.S. faculty is aware of these meetings,
 1522 which are often organized around the nation; the detachment of
 1523 all professors from the public is concerning; 48% admit to talk
 1524 with non-academicians occasionally (The Pew Research
 1525 Center for the People & the Press 2009). (9) Participate in
 1526 and sponsor multidisciplinary conferences (anthropology,
 1527 biology, education, ethics, history, law, philosophy, political
 1528 science, social psychology, religious studies) to learn the
 1529 theoretical and practical aspects of civil action to counter the
 1530 antievolution campaigns, anti-intellectualism tendencies, and
 1531 pro creationism and ID agendas (Young and Edis 2004; Petto
 1532 and Godfrey 2007; Coalition of Scientific Societies 2008;
 1533 Williams 2009). And (10) monitor the antievolution move-
 1534 ments that grow strong among misinformed citizens, vary in
 1535 impact geographically, and benefit from the disconnect
 1536 between highly-educated audiences, like educators of prospec-
 1537 tive teachers/general faculty, and society (Paz-y-Miño-C and
 1538 Espinosa 2011a; note that the [National Center for Science](#)
 1539 [Education](#) monitors the antievolution movement, see link in
 1540 references). The regional differential acceptance of evolution
 1541 in the U.S. (i.e., northeast, 59%; northwest, 57%; midwest,
 1542 45%; south, 38%; The Pew Research Center for the People &
 1543 the Press 2005) suggests that pro-evolution campaigns require
 1544 strategies compatible with local idiosyncrasies (Paz-y-Miño-C
 1545 and Espinosa 2011a); the educators of prospective teachers

1546 must take the lead in conceptualizing and strategizing the civil
 1547 discourse and societal action to ensure internationally
 1548 competitive science/evolution literacy in the U.S.

Significance of this Study 1549

1550 This is the first study to explore statistically and compara-
 1551 tively the views of a representative sample of 62 highly
 1552 trained educators of prospective teachers (87% Ph.D./
 1553 doctorate holders who work in 32 specializations) in respect
 1554 to 244 general faculty (93% Ph.D./doctorate holders in 40
 1555 disciplines), affiliated with 35 academic institutions (public,
 1556 private, and religious), widely distributed geographically in
 1557 New England (states of Connecticut, Maine, Massachusetts,
 1558 New Hampshire, Rhode Island, and Vermont), and 827
 1559 college students (subsample of the 35 institutions) who were
 1560 polled in three areas: (1) the controversy over evolution
 1561 versus creationism versus ID, (2) their understanding of
 1562 how science/evolution works, and (3) their religiosity. Our
 1563 survey was conducted in one of the most progressive and
 1564 intellectual regions in the U.S., where public acceptance of
 1565 evolution is the highest nationwide (59%). The educators of
 1566 prospective teachers consistently held intermediate positions
 1567 about the three surveyed areas (above) in respect to the
 1568 general faculty and the students. Understanding of science
 1569 and evolution correlated inversely with level of religiosity,
 1570 and understanding of evolution increased with increasing
 1571 science literacy. The general faculty were the most knowl-
 1572 edgeable about science/evolution and the least religious,
 1573 while the educators reached lower science/evolution—but
 1574 higher religiosity—levels than the general faculty; the edu-
 1575 cators views were statistically comparable to the students’
 1576 who were the least knowledgeable about science/evolution
 1577 and the most religious. The patterns of hesitant support to
 1578 evolution by the educators of prospective teachers, due to a
 1579 deficient understanding of science and the evolutionary
 1580 process, combined with high religiosity, are concerning
 1581 since these educators are responsible for mentoring prospec-
 1582 tive teachers. Adequate training in science/evolution is in-
 1583 dispensable among all education specialists to minimize the
 1584 negative impact of creationism and ID on the U.S. educa-
 1585 tional system.

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