# Attitudes Toward Evolution At New England Colleges And Universities, United States

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## NE Science Public

# ATTITUDES TOWARD EVOLUTION AT NEW ENGLAND COLLEGES AND UNIVERSITIES, UNITED STATES

## Executive Summary

Based on current scientific evidence, 100% of all people should accept the *concept of evolution* which provides naturalistic explanations about the origin of life, its diversification and biogeography, and the synergistic phenomena resulting from the interaction between life and the environment.

In the United States (US), creationism and Design Creationism/Intelligent Design split the public's support to evolution: 40% of adults accept it but about two in every three Americans doubt or challenge the reality of evolution.

*Rationale*  The assumption that in the ideologically progressive and highly educated Northeastern US (where public acceptance of evolution is the highest nationwide, only 59%) the research professors, educators of prospective teachers and their college students were consistently supportive of science/evolution, and remained distant from belief-based perspectives about the natural world, required close analysis:

Between 2009 and 2012, we examined the views of the *New England Faculty* (*N* = 244) and the *Educators of Prospective Teachers* (*N* = 62; higher-education faculty themselves, specialized in training future teachers) from 35 colleges and universities, as well as a representative sample of *College Students* from a *Public*, *Private* and two *Religious* institutions (student grand total *N* = 827) who were polled in three areas:

> The controversy over evolution versus creationism versus Intelligent Design.
>
> Their understanding of how science and the evolutionary process work.
>
> Their personal convictions concerning the evolution and/or creation of humans in the context of their religiosity.

Our significant findings included:

1) Understanding of science and acceptance of evolution decreased with increasing religiosity in all groups (= negative association of variables). Acceptance of evolution increased with higher levels of understanding science (= positive association of variables). The non-religious responders reached the highest levels of understanding science and evolution in contrast to the deeply-religious who scored lowest in *science-* and *evolution-literacy* parameters (= estimated indexes).

2) The New England Faculty scored high in science and evolution literacy and low in religiosity; the Educators of Prospective Teachers scored intermediate in science and evolution literacy as well as in religiosity; and the College Students (a population still in-training) scored, as expected, low(er) in science and evolution literacy and high(er) in religiosity.

3) Most New England Faculty accepted evolution openly, followed by the majority of Educators of Prospective Teachers and College Students. Private acceptance of evolution was rare among the New England Faculty but noticeable among the Educators of Prospective Teachers and the College Students. At least one in ten Educators of Prospective Teachers and one in five College students preferred to not express an opinion concerning acceptance of evolution either openly or privately, a rare view among the New England Faculty.

4) Among College Students from either Public, Private or Religious institutions, the biology majors were more inclined to accept evolution than the non-majors. Acceptance of evolution among the biology majors increased conspicuously with academic level, from the Freshman to the Senior years. At least one in every fifteen biology majors and one in every ten non-majors were openly or privately creationists.

5) Most New England Faculty and the majority of Educators of Prospective Teachers and College Students thought that evolution alone should be taught in science classes. "Equal time" to evolution, creationism or Intelligent Design was unpopular among the New England Faculty, but conceivable among the Educators of Prospective Teachers and one in every three College Students supported it.

6) More New England Faculty than Educators of Prospective Teachers or College Students thought that evolution is definitely true. The doubtful position, or "probably true," was more common among the College Students than among the Educators of Prospective Teachers or the New England Faculty.

7) One in every three New England Faculty, two in every three Educators of Prospective Teachers, and three in every four College Students had a Lamarckian understanding of the evolutionary process (i.e. believed that organisms acquire traits during their lifetimes, such as longer necks, larger brains, resistance to parasites, and then pass on these traits to their descendants –which is a pervasive cultural misconception).

8) One in every four New England Faculty, one in every two Educators of Prospective Teachers and one in every three College Students did not know that humans are apes, relatives of chimpanzees, bonobos, gorillas and orangutans.

9) One in every seven New England Faculty, one in every three Educators of Prospective Teachers and College Students did not know that the origin of the human mind and consciousness can indeed be explained by evolution.

10) One in every five New England Faculty, two in every five Educators of Prospective Teachers and one in every two College Students thought incorrectly that the universe, our solar system and planet Earth are finely tuned to embrace human life.

## Conclusions and Implications of the Results

1) Public acceptance of evolution in New England –although the highest in the US— is only 59%, which suggests that the education system and, specifically here, college education is not fully effective in communicating the reality of evolution to the New England students (= the soon-to-be the "regional public"). Only biology major students seem to receive strong education in matters of evolution. Biology majors are the only student population surpassing the regional level (59%) of acceptance of evolution at the time of graduation, but what is accomplished is insufficient; based on our samples, only 82.6% of the graduates from the Public, 64.9% from the Private, and 66.5% from the Religious institutions accepted evolution openly.

2) Although the professors at the New England colleges and universities showed high levels of understanding science and acceptance of evolution, their colleagues specialized in training future teachers (i.e. the Educators of Prospective Teachers) consistently hesitated to embrace evolution and scored below in science/evolution and above in religiosity when compared to the non-educators faculty (i.e. 41.5% of the Educators of Prospective Teachers versus 29.0% of the New England Faculty –still a surprisingly high score— considered religion to be *very important in their lives*!). Because we assume that the PhD- or doctoral-training levels in *pedagogy* (= specialization of the Educators of Prospective Teachers) or in *other academic fields* (= what we call in our studies the "New England Faculty") are analogously rigorous in the US, we conclude that the hesitation to fully embrace evolution by the Educators of Prospective Teachers is inherent to their deficient understanding of science/evolution and high religiosity. Although differences in attitudes toward evolution by professors in diverse fields and geographic regions of the US are conceivable, our sample of the New England Faculty generated unambiguous responses (e.g. 94.4/2.8% open/private acceptance of evolution and 2.8% no opinion) in contrast to the cautious views held by the Educators of Prospective Teachers (75.0/12.5% open/private acceptance of evolution and 12.5% no opinion).

3) Our findings are consistent with the hypothesis that the controversy over science/evolution and creationism is inherent to the incompatibility between scientific rationalism/empiricism and the belief in supernatural causation. The negative association of variables in all analyses between level of religiosity and level of understanding science/evolution, and the positive association between science literacy and evolution literacy support the hypothesis. Long-term harmonious coexistence between science/evolution and creationism –and all its forms— is illusory. Societies will struggle indefinitely with this incompatibility, therefore the interaction between science/evolution and religiosity is destined to fluctuate historically between intense and moderate antagonism.

## Application

Testing faculty's (researchers and educators) versus students' conceptual perception of evolution in one of the historically most progressive regions of the US allowed us to assess the impact caused by creationist views on the attitudes toward science, reason, and the education in science at a geographically large study-landscape. In this *NE Science Public: Series Evolution* we provide specific recommendations to improve the approach with which evolution and science are communicated to/by these three populations.

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# ATTITUDES TOWARD EVOLUTION AT NEW ENGLAND COLLEGES AND UNIVERSITIES, UNITED STATES

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## Introduction

Based on current scientific evidence, 100% of all people should accept the *concept of evolution* which provides naturalistic explanations about the origin of life, its diversification and biogeography, and the synergistic phenomena resulting from the interaction between life and the environment (Paz-y-Miño-C & Espinosa 2011a). However, only 41% of adults worldwide (24 countries, $N$ = 18,829) accept evolution, and they do it under the premise that a deity created humans; 31% do not know who to trust in matters of evolution (i.e. neither scientists nor spiritualists); and 28% are strict creationists who believe in religious scriptures concerning the origin of our universe and of humans (e.g. *Genesis*: the creation of the universe by God a few thousand years ago = *Young Earth Creationists —YEC* views are common in most belief-based interpretations about *origins*), and explicitly reject the fact that humans are apes (IPSOS 2011).

In the United States, creationism and Design Creationism/Intelligent Design split the public's support to evolution: 40% of adults accept it but about two in every three Americans doubt or challenge the reality of evolution. The US ranks 33rd among 34 other industrialized countries where acceptance of evolution has been polled, in contrast to Iceland, Denmark, Sweden, France, Japan and the United Kingdom, top in the list, where ≈ 75-85% of the general public accepts evolution (Miller et al. 2006). In the intellectually progressive Northeastern US –the focus region of our studies— favorable views toward evolution are the highest nationwide, only 59% (The Pew Research Center For The People & The Press 2005).

In this article, we compile the most significant results of our conceptual and quantitative studies on the patterns of acceptance of evolution at New England colleges and universities, which we have conducted between 2009 and 2012:

> Paz-y-Miño-C G. & Espinosa A. 2012a. Introduction: Why People Do Not Accept Evolution: Using Protistan Diversity To Promote Evolution Literacy. *Journal of Eukaryotic Microbiology* 59: 101–104.
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> Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162.
>
> Paz-y-Miño-C G. & Espinosa A. 2011a. On The Theory Of Evolution Versus The Concept Of Evolution: Three Observations. *Evolution: Education & Outreach* 4: 308–312.
>
> Paz-y-Miño-C G. & Espinosa A. 2011b. New England Faculty And College Students Differ In Their Views About Evolution, Creationism, Intelligent Design, And Religiosity. *Evolution: Education & Outreach* 4: 323–342.
>
> Paz-y-Miño-C G. & Espinosa A. 2009a. Assessment Of Biology Majors' Versus Non-majors' Views On Evolution, Creationism And Intelligent Design. *Evolution: Education & Outreach* 2: 75–83.
>
> Paz-y-Miño-C G. & Espinosa A. 2009b. Acceptance Of Evolution Increases With Student Academic Level: A Comparison Between A Secular And A Religious College. *Evolution: Education & Outreach* 2: 655–675.

Although by 2009 acceptance of evolution among the US general public, high school students and teachers, college students and scientists had been broadly documented, little was known about tendencies of acceptance of evolution by highly educated audiences, like university professors, educators of prospective teachers (higher-education faculty themselves, specialized in training future teachers), or even students at the prestigious New England colleges and universities. The cultural assumption in Northeastern US had been that such audiences were consistently supportive of science and remained distant from belief-based perspectives about the natural world. We were skeptical about these premises and decided to test them conceptually and quantitatively (most studies nationwide had been descriptive and not hypothesis oriented).

We examined the views of the *New England Faculty* and the *Educators of Prospective Teachers* from 35 colleges and universities, as well as a representative sample of *College Students* from a *Public*, *Private* and two *Religious* institutions. All were polled (= online surveys distributed via email, see Methods) in three areas: (1) the controversy over evolution versus creationism versus Intelligent Design, (2) their understanding of how science and the evolutionary process work, and (3) their personal convictions concerning the evolution and/or creation of humans in the context of their own religiosity.

Testing faculty's versus students' conceptual perception of evolution in one of the historically most progressive regions of the US allowed us to assess the magnitude of the impact caused by creationism and Intelligent Design on the attitudes toward science, reason, and the education in science at a geographically large study-landscape. Note that the New England states have among the highest evolution education standards in the US (*letter grade* for coverage of evolution in state science standards: Connecticut *D*, Maine *C*, Massachusetts *B*, New Hampshire *A*, Rhode Island *B*, Vermont *B*; Mead & Mates 2009), however only two out of three New Englanders accept evolution.

By understanding opinions about evolution by 'highly educated' versus 'in-the-process-of-acquiring-education' audiences, we also aimed at providing guidelines to improving the approach with which evolution and science are communicated to the public, contributing to curricular/pedagogical reform for their effective teaching in college, and minimizing the negative effects of creationism and Intelligent Design on the US educational system.

## DEFINITIONS

*Evolution*  The concept of evolution provides naturalistic explanations about the origin of life, its diversification and biogeography, and the synergistic phenomena resulting from the interaction between life and the environment; mutations, gene flow, genetic drift and natural selection shape life's biological processes in Earth's ecosystems. Since the publication of *The Origin of Species* by Charles Darwin, in 1859, Darwinian evolution has been scrutinized experimentally; today the *theory of evolution* is widely accepted by the scientific community.

*Creationism*  In contrast to evolution, creationism, theistic evolution, creation science or young-earth creationism rely on supernatural causation to explain the origin of the universe and life. These views are not recognized by scientists as evidence-based explanations of empirical reality, or of cosmic processes which, according to modern understanding of "cosmic evolution" (as in Krauss 2010), do encompass the formation of the universe, the emergence of the simplest elements that transformed into more complex elements and molecules, including prebiotic compounds in our planet and that, ultimately, led to the evolution of molecular diversity and complexity of today's living organisms and ecosystems.

*Design Creationism or Intelligent Design*  The doctrine of ID, born in the 1980s, proposes that a Designer is responsible, ultimately, for the assemblage of complexity in biological systems; according to ID, evolution cannot explain holistically the origin of the natural world, nor the emergence of intricate molecular pathways essential to life, nor the immense phylogenetic differentiation of life, and instead ID proposes an *intelligent agent* as the ultimate cause of nature. In conceptually mistaken, type-I-error-based arguments to discredit evolution, ID has attributed randomness to molecular change, deleterious nature to single-gene mutations, insufficient geological time or population size for molecular improvements to occur, and invoked "design intervention" to account for complexity in molecular structures and biological processes. In 2005, ID was exposed in court for violating the rules of science by "invoking and permitting supernatural causation" in matters of evolution, and for "failing to gain acceptance in the scientific community." Today, "design creationism" (as we refer to ID due to its designer/creator-based foundations), although defeated by science and in the courts, grows influential in the US, Europe, Australia and South America.

*Note*  For a conceptual analysis about science/evolution and supernatural causation see Paz-y-Miño-C G. & Espinosa A. 2013. The Everlasting Conflict Evolution-And-Science Versus Religiosity. Pp. 73-97. In Simpson G & Payne S (eds). *Religion And Ethics*, NOVA Publishers, New York.

## THE APPROACH

### Conceptual Understanding of the Interaction between
### Scientific Rationalism/Empiricism and the Belief in Supernatural Causation

We have hypothesized and tested that the controversy over evolution-and-science versus creationism (the latter exemplified by, but not restricted to, Intelligent Design, see Definitions above) is inherent to the incompatibility between scientific rationalism/empiricism and the belief in supernatural causation (Paz-y-Miño-C & Espinosa 2012a). To examine this hypothesis theoretically and test it quantitatively, we conceptualized a Cartesian landscape where the dependent variable acceptance of evolution was plotted as function of three factors (Figure 1): personal religious convictions (= belief), understanding how evolution works (= familiarity with the processes and forces of change in organisms), and understanding the essence of science (= method to explore reality).

The point zero in the Cartesian landscape depicted in Figure 1, from which coordinates *x*, *y* and *z* originate, corresponds to a low (labeled *none*) religiosity, evolution, or science awareness condition, or a *no awareness corner*, which is a low probability of occurrence corner (LPC). Away from zero, the tips of the coordinates' arrows correspond to a high or *deep* religiosity, evolution, or science awareness. The highest acceptance of evolution corner is located in the top right of the landscape, where religiosity is low or none and evolution and science awareness are high or deep. The lowest acceptance of evolution corner is located in the bottom left of the landscape, where religiosity is high or deep and evolution and science awareness are low or none. A potentially highest personal conflict corner resides at the intersection of high or deep religiosity and evolution and science awareness; this potential conflict condition, however, can be resolved by the individual adopting comforting positions, such as: evolution and creationism are in harmony, non-overlapping magisteria (NOMA = science and religion occupy separate domains, as in Gould 1999), or agnosticism (doubt about the existence or nonexistence of a deity). Note that four other corners are labeled LPC in Figure 1 due to their low probability of occurrence (e.g. high or deep understanding of science combined with no understanding of evolution and no religiosity, which is unlikely).
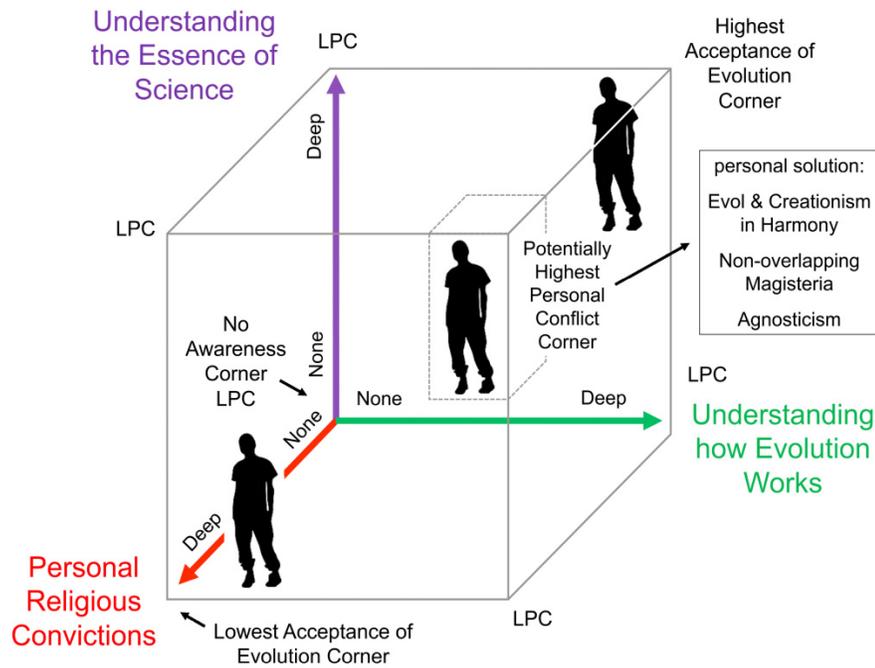
**Figure 1** Conceptual Three Dimensional Landscape Where Acceptance of Evolution is Depicted as Function of Religiosity, Science Awareness and Evolution Literacy (adapted from Paz-y-Miño-C G. & Espinosa A. 2012a. Introduction: Why People Do Not Accept Evolution: Using Protistan Diversity To Promote Evolution Literacy. *Journal of Eukaryotic Microbiology* 59: 101–104, with permission).

## THE STRATEGY TO TEST THE HYPOTHESIS

### *Quantification of the Interaction between Science-Evolution and Supernatural Causation*

To quantitate the levels of religiosity, understanding of science and the evolutionary process and plot them according to the parameters depicted in Figure 1, we used three descriptive indexes as characterizers of acceptance of evolution, each ranging from 0 to 3 (least to most religious or knowledgeable about science or evolution): Religiosity Index *RI* (The Pew Global Attitudes Project 2007), Science Index *SI* and Evolution Index *EI* (Paz-y-Miño-C & Espinosa 2011b). These indexes are powerful predictors of religious views worldwide (47 countries, The Pew Global Attitudes Project 2007) and of levels of understanding science and the evolutionary process (e.g. sample of 1,133 US adults with diverse academic backgrounds, from college students to university professors; Paz-y-Miño-C & Espinosa 2011b, 2012b, 2013).

Each index relies on examining responses to simple, informative questions:

Religiosity Index *RI*

> +1 if responders believe that *faith in God is necessary for morality*,
> +1 if *religion is very important in their lives*, and
> +1 if *they pray daily*.

> New England Faculty RI = 0.49
> Educators of Prospective Teachers RI = 0.83
> College Students RI = 0.89
> Kruskal-Wallis one-way ANOVA on ranks, $H = 21.734$, $df = 2$, $P \leq 0.001$

Science Index *SI*

> +1 if responders reject the idea that *scientific theories are based on opinions by scientists*,
> +1 if they disagree with the notion that *scientific arguments are as valid and respectable as their non-scientific counterparts*, and
> +1 if they reject the statement that *crime-scene and accident-scene investigators use a different type of scientific method to investigate a crime or an accident*.

> New England Faculty SI = 2.49
> Educators of Prospective Teachers SI = 1.96
> College Students SI = 1.80
> Kruskal-Wallis one-way ANOVA on ranks, $H = 89.365$, $df = 2$, $P \leq 0.001$

Evolution Index *EI*

+1 if responders reject the idea that *organisms acquire beneficial traits during their lifetimes and then pass on these traits to their descendants*,
+1 if they disagree with the notion that *during evolution monkeys such as chimpanzees can turn into humans*, and
+1 if they reject the statement that *the origin of the human mind and consciousness cannot be explained by evolution*.

New England Faculty EI = 2.49
Educators of Prospective Teachers EI = 1.96
College Students EI = 1.60
Kruskal-Wallis one-way ANOVA on ranks, $H$ = 171.683, $df$ = 2, $P \leq 0.001$
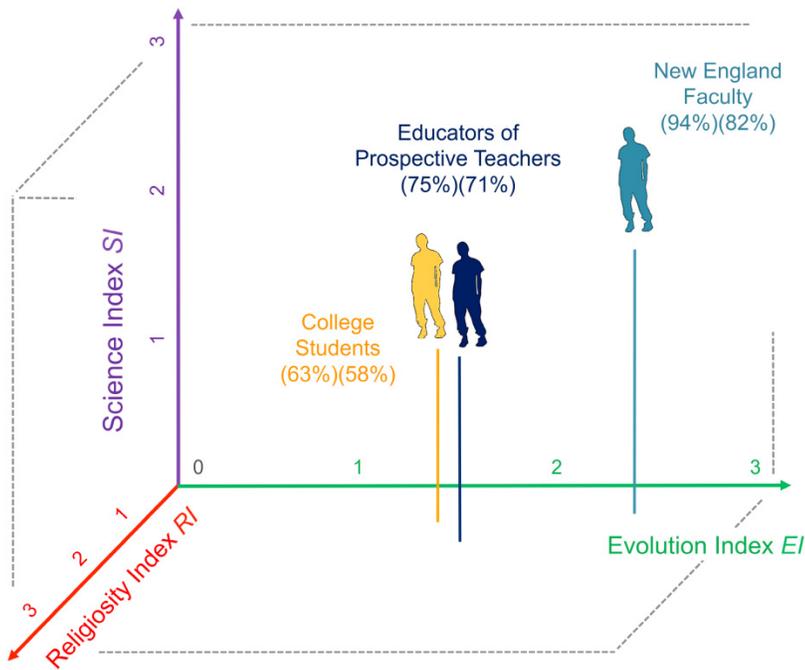
New England Faculty $N$ = 222, Educators of Prospective Teachers $N$ = 53, College Students $N$ = 576

   The data above revealed the following pattern: the New England Faculty were the most knowledgeable about science and evolution and the least religious; the Educators of Prospective Teachers reached lower science- and evolution- but higher religiosity- indexes than the New England Faculty; and the College Students (= population in training) were the least knowledgeable about science and evolution and the most religious.

*RI in the Context of Northeastern US, North America, the World*  It is important to emphasize that the religiosity indexes of the samples of New England Faculty and the Educators of Prospective Teachers/College Students were three and ca. two times below the US national score of Religiosity Index *RI* = 1.40, $N$ = 2,026 (The Pew Global Attitudes Project 2007), respectively, but that only the New England Faculty had a level of religiosity comparable to that of the general public in Western Europe, the lowest worldwide (The Pew Global Attitudes Project 2007; Paz-y-Miño-C & Espinosa 2011b). The Educators of Prospective Teachers sampled here were statistically as religious as the College Students (Dunn-test two-tail pair-wise comparison $P \leq 0.05$) and more religious than the Canadian general public (*RI* = 0.72, The Pew Global Attitudes Project 2007) whose overall acceptance of evolution is 58%, although 63% of East Coast Canadians accept evolution ($N$ = 1,007; Angus Reid Strategies 2008), which is comparable to 59% of their East Coast American counterparts (The Pew Research Center for The People & The Press 2005).

## THE ATTITUDES TOWARD EVOLUTION

*Acceptance of Evolution among the New England Faculty versus the Educators of Prospective Teachers versus the College Students*



   In Figure 2, acceptance of evolution among New England Faculty, Educators of Prospective Teachers and College Students is plotted as function of their personal religious convictions (Religiosity Index *RI*), understanding of science (Science Index *SI*), and understanding of evolution (Evolution Index *EI*). The three-dimensional landscape is consistent with the theoretical parameters depicted in Figure 1; note, however, that in Figure 2 the scale of each dimension differs to enhance the display of data. The New England faculty held the highest acceptance of evolution position, followed by the Educators of Prospective Teachers, and the College Students.

**Figure 2** Acceptance of Evolution Among New England Faculty, Educators of Prospective Teachers and College Students as Function of Their Religiosity, Science Awareness and Evolution Literacy. The New England faculty held the highest acceptance of evolution position ($N$ = 244, *RI* = 0.49, *SI* = 2.49, *EI* = 2.49), followed by the educators of prospective teachers ($N$ = 62, *RI* = 0.83, *SI* = 1.96, *EI* = 1.96), and college students ($N$ = 827, *RI* = 0.89, *SI* = 1.80, *EI* = 1.60). Percentage values written within brackets correspond to responders admitting to *accept evolution openly regardless of others opinions* (first value), or thinking that *evolution is definitely true* (second value). Adapted from Paz-y-Miño-C G. & Espinosa A. 2012a. Introduction: Why People Do Not Accept Evolution: Using Protistan Diversity To Promote Evolution Literacy. *Journal of Eukaryotic Microbiology* 59: 101–104, with permission.

## *Understanding of Science/Evolution Was High Among the Non-religious, But Low Among the Religious*

The levels of understanding of science and evolution by the New England Faculty, Educators of Prospective Teachers, and College Students decreased with increasing religiosity (= negative association of variables, Figures 3 and 4); in contrast, the levels of understanding of evolution increased with increasing understanding of science (= positive association of variables, Figure 5).
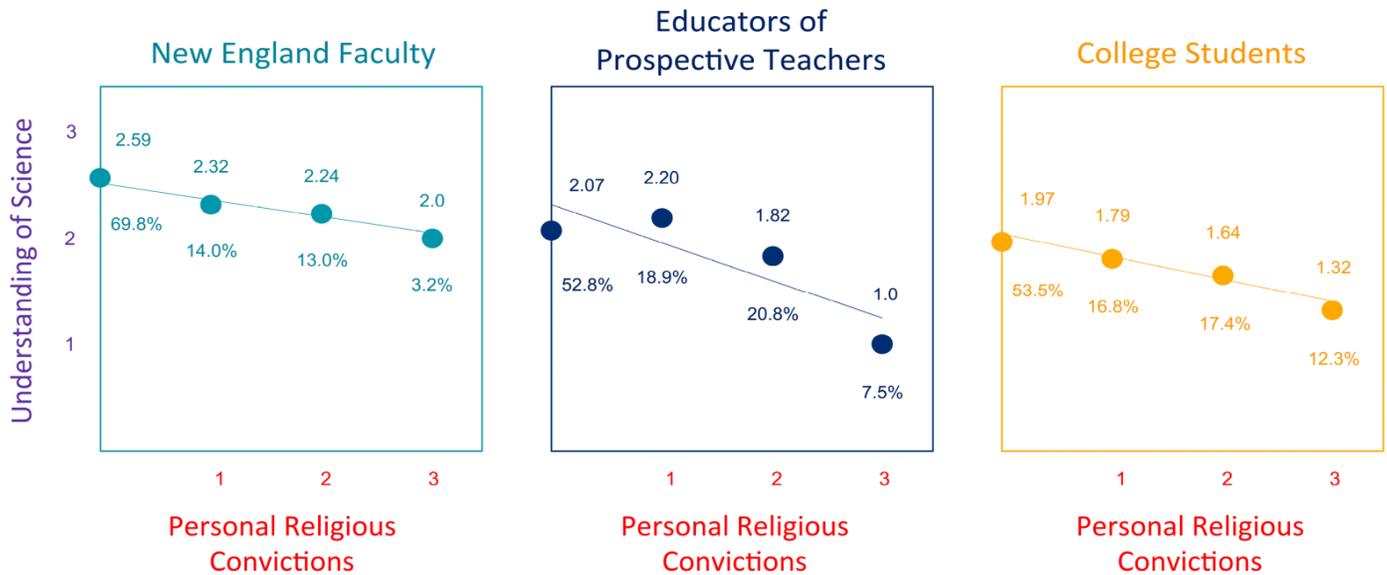


**Figure 3** Understanding of Science is High Among the Non-religious and Low Among the Deeply Religious.
Linear regressions one tail: New England Faculty $R^2$ = 0.964, $P$ = 0.009, $N$ = 222; Educators of Prospective Teachers $R^2$ = 0.740, $P$ = 0.069, $N$ = 53; College Students $R^2$ = 0.969, $P$ = 0.007, $N$ = 576. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.



**Figure 4** Understanding of Evolution is High Among the Non-religious and Low Among the Deeply Religious.
Linear regressions one tail: New England Faculty $R^2$ = 0.811, $P$ = 0.049, $N$ = 222; Educators of Prospective Teachers $R^2$ = 0.974, $P$ = 0.006, $N$ = 53; College Students $R^2$ = 0.894, $P$ = 0.027, $N$ = 576. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.
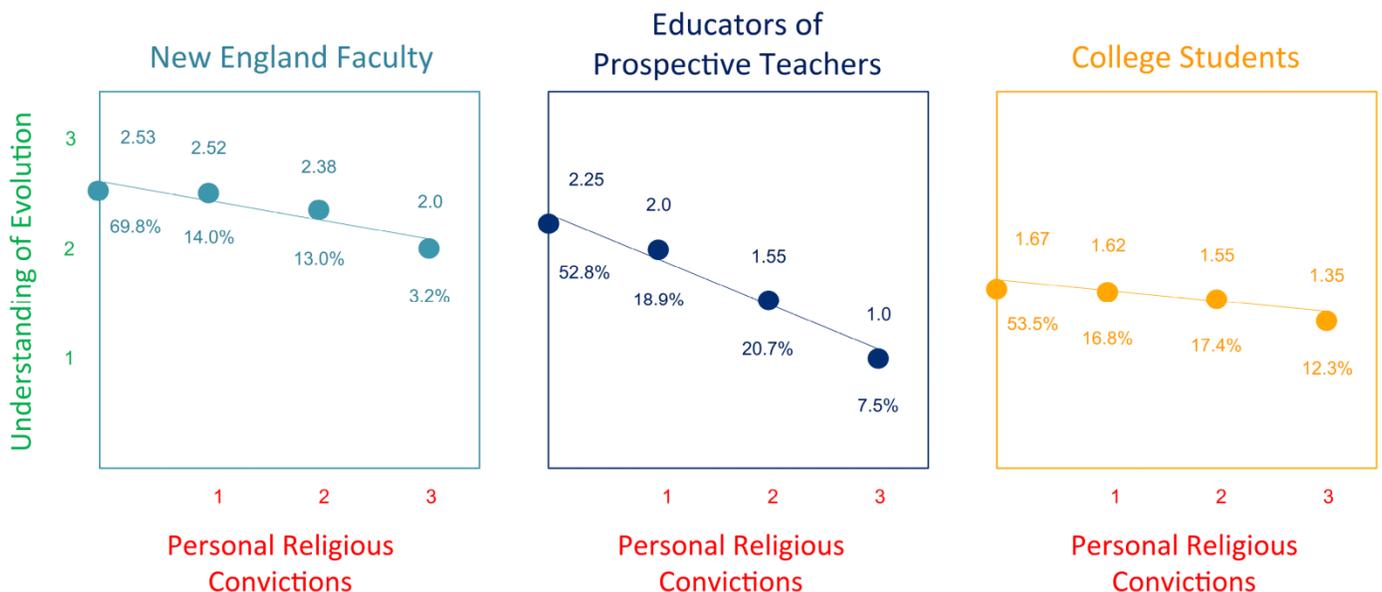
**Figure 5** Understanding of Evolution is High Among Those With High Understanding of Science.
Linear regressions one tail: New England Faculty $R^2$ = 0.989, $P$ = 0.002, $N$ = 222; Educators of Prospective Teachers $R^2$ = 0.921, $P$ = 0.020, $N$ = 53; College Students $R^2$ = 0.996, $P$ = 0.0005, $N$ = 576. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.
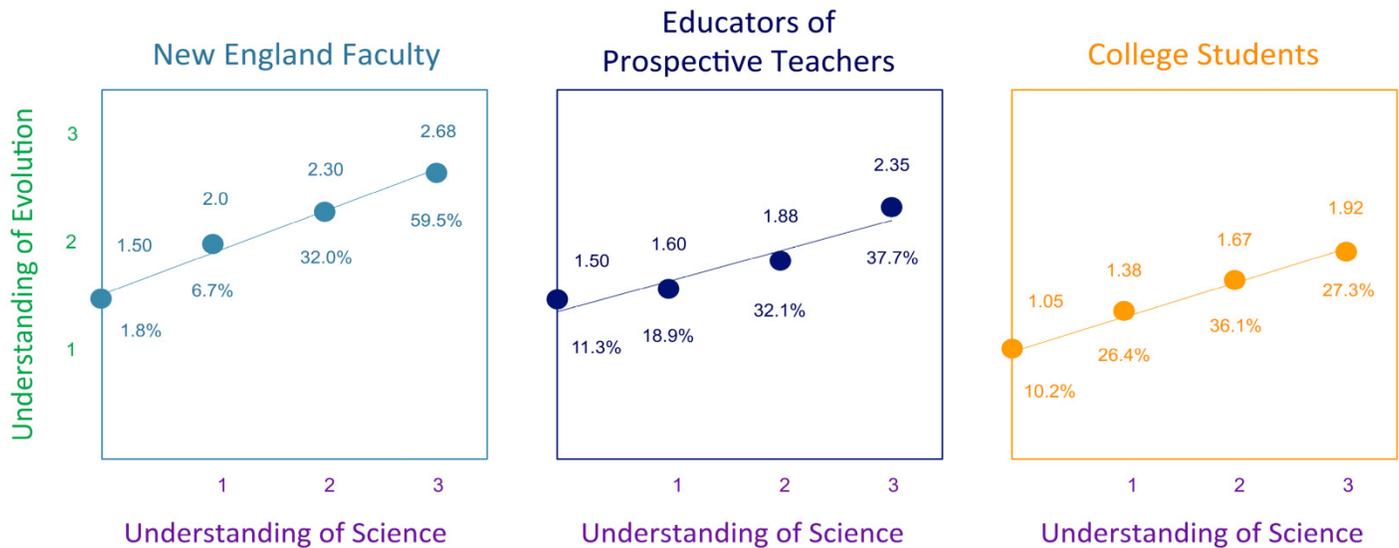
The Science Index SI, Evolution Index EI and Religiosity Index RI patterns reported in Figures 3, 4 and 5 were in accordance with the proposal that the interaction between science/evolution literacy and level of religiosity determine an individual's acceptance of evolution, which was corroborated by the data shown in Figure 2: first, the overall high and open acceptance of evolution by the New England Faculty (94%), intermediate by the Educators of Prospective Teachers (75%), and low by the College Students (63%); and, second, the observation that 82% of the New England Faculty (high), 71% of the Educators of Prospective Teachers (intermediate), and 58% of the College Students (low) thought that evolution is definitely true.

## How do the Non-Religious Differ in their Understanding of Science/Evolution from the Religious?

The majority of the New England Faculty, Educators of Prospective Teachers, and College Students scored zero in Religiosity Index *RI*, and Figure 6 depicts their levels of understanding science and evolution as function of their non-religiosity. The colored areas in the circles correspond to the percentage of the non-religious responders in respect to the total number of individuals surveyed within groups. The center of each circle is aligned with the levels of understanding science or evolution (Science Index *SI* or Evolution Index *EI*, respectively, as in Figure 2), values shown on the vertical axis. Note how, for the non-religious New England Faculty and Educators of Prospective Teachers, the Science and Evolution Indexes were relatively high (New England Faculty *SI* = 2.59 and *EI* = 2.53, Educators of Prospective Teachers *SI* = 2.07 and *EI* = 2.25), although the College Students, a population in academic training, had *SI* and *EI* below 2.0.

A minority of the New England Faculty, Educators of Prospective Teachers, and College Students scored very high in religiosity, which is shown in Figure 7. Note that, in contrast to Figure 6, the understanding of science and evolution were particularly low among the deeply religious (*SI* and *EI* below 2.0 for the three groups); for the religious Educators of Prospective Teachers the *SI* (= 1.0) and *EI* (= 1.0) scores were even lower than those for the students (*SI* = 1.32, *EI* = 1.35). However, the number of very religious professors was in the single digits (New England Faculty *N* = 7 or 3.2%, Educators of Prospective Teachers *N* = 4 or 7.5%).

Here it is crucial to report that 29.0% of the New England Faculty, 41.5% of the Educators of Prospective Teachers, and 37.3% of the College Students considered the statement *religion is very important in my life* –one of the three statements to assess religiosity— as true (data not shown, but see details in Paz-y-Miño-C & Espinosa 2012b).
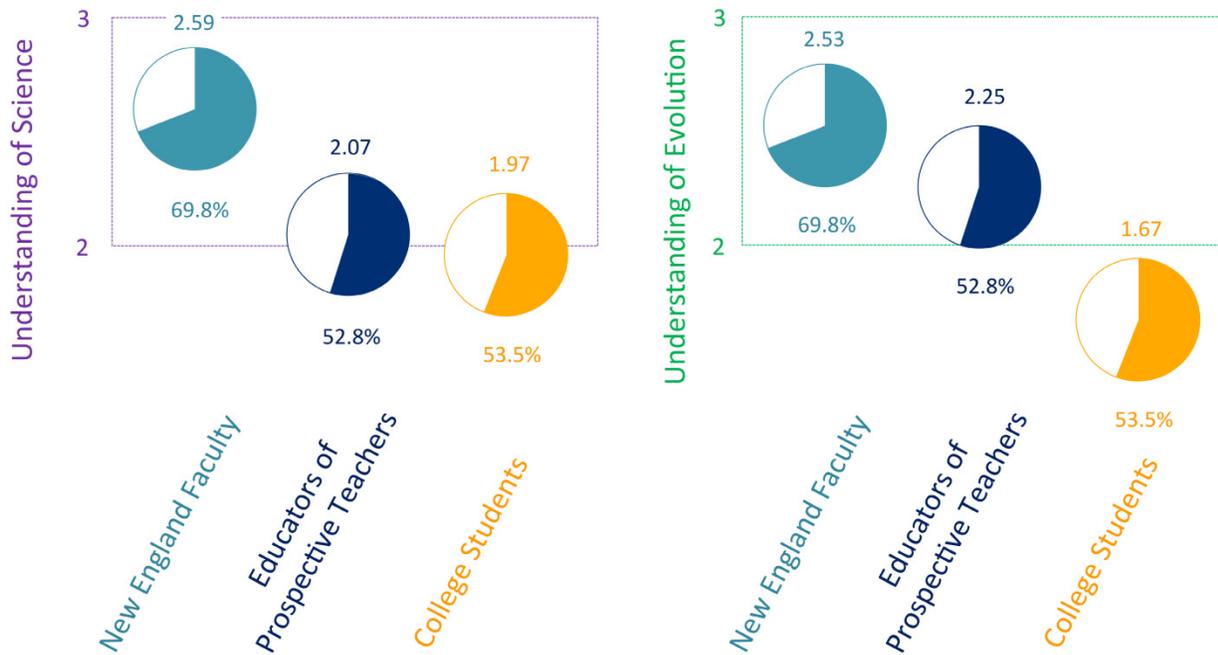
**Figure 6** Understanding of Science and Evolution as Percentile of the Non-religious. The majority of the New England Faculty, Educators of Prospective Teachers, and College Students score zero in religiosity. For understanding of science: Kruskal-Wallis one-way ANOVA on ranks, $H$ = 54.136, $df$ = 2, $P$ ≤ 0.001. For understanding of evolution: Kruskal-Wallis one-way ANOVA on ranks, $H$ = 106.354, $df$ = 2, $P$ ≤ 0.001. New England Faculty $N$ = 155, Educators of Prospective Teachers $N$ = 28, College Students $N$ = 308. **Note** atheists $N$ = 133, $SI$ = 2.34, $EI$ = 2.41, see Paz-y-Miño-C G. & Espinosa A. 2013. The Everlasting Conflict Evolution-And-Science Versus Religiosity. Pp. 73-97. In Simpson G & Payne S (eds). *Religion And Ethics*, NOVA Publishers, New York.
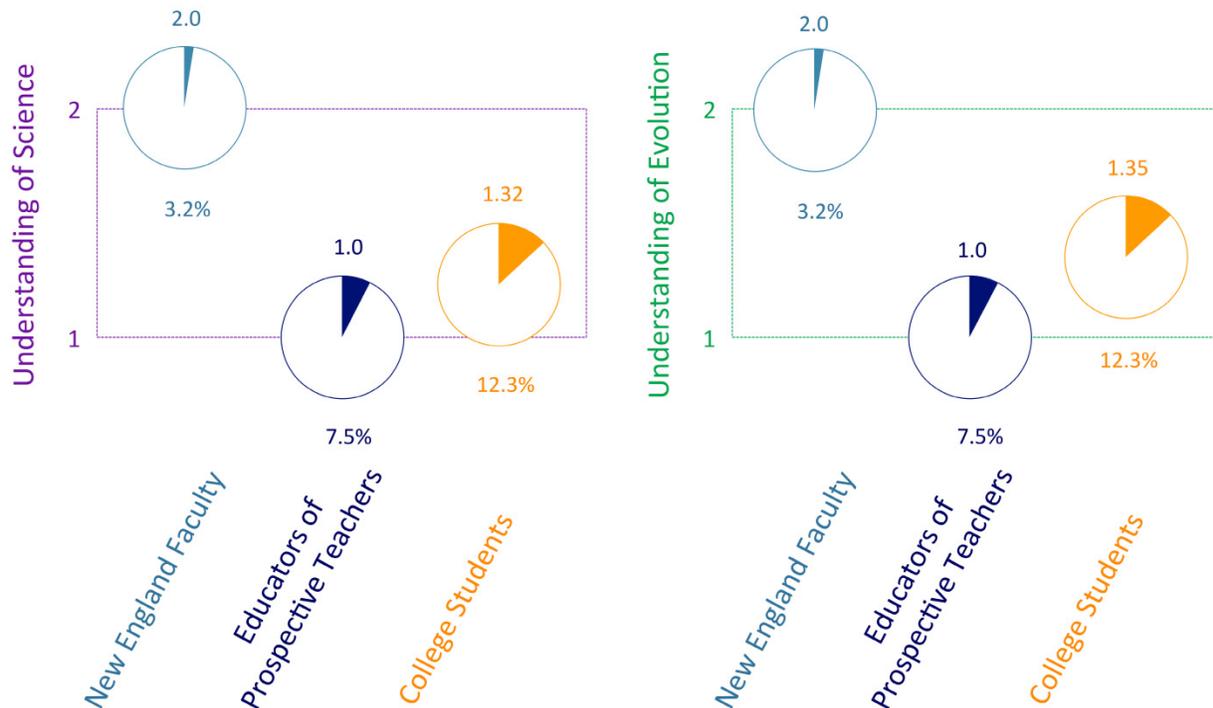


**Figure 7** Understanding of Science and Evolution as Percentile of the Deeply Religious. The minority of the New England Faculty, Educators of Prospective Teachers, and College Students score very high in religiosity. Colored areas in circles correspond to the percentage of the most religious in respect to the total number of individuals surveyed within groups. The center of each circle is aligned with the level of understanding science (Science Index $SI$, as in Figure 2) or the level of understanding evolution (Evolution Index $EI$, as in Figure 2), values on the vertical axis. For understanding of science: Kruskal-Wallis one-way ANOVA on ranks, $H$ = 3.566, $df$ = 2, $P$ = 0.168. For understanding of evolution: Kruskal-Wallis one-way ANOVA on ranks, $H$ = 6.484, $df$ = 2, $P$ = 0.039. New England Faculty $N$ = 7, Educators of Prospective Teachers $N$ = 4, College Students $N$ = 71. **Note** Educators of Prospective Teachers entire US $N$ = 76, $SI$ = 1.57 (18.5%), $EI$ = 1.25 (18.5%), see Paz-y-Miño-C G. & Espinosa A. 2013. The Everlasting Conflict Evolution-And-Science Versus Religiosity. Pp. 73-97. In Simpson G & Payne S (eds). *Religion And Ethics*, NOVA Publishers, New York.
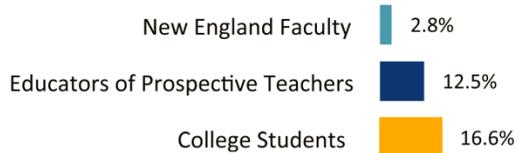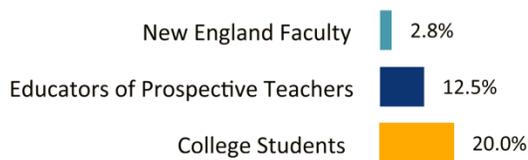
## Accept Evolution Openly

New England Faculty — 94.4%
Educators of Prospective Teachers — 75.0%
College Students — 63.4%

## Accept Evolution Privately

New England Faculty — 2.8%
Educators of Prospective Teachers — 12.5%
College Students — 16.6%

## No Opinion

New England Faculty — 2.8%
Educators of Prospective Teachers — 12.5%
College Students — 20.0%

### Open or Private Acceptance of Evolution

Most New England Faculty accepted evolution openly, followed by the majority of Educators of Prospective Teachers and College Students (Figure 8). Private acceptance of evolution was rare among the New England Faculty but noticeable among the Educators of Prospective Teachers and the College Students. Interestingly, at least one in ten Educators of Prospective Teachers and one in five College students preferred to not express an opinion concerning acceptance of evolution either openly or privately, a rare view among the New England Faculty.

**Figure 8** Most New England Faculty Accept Evolution Openly, Followed by the Majority of Educators of Prospective Teachers and College Students. Comparisons among groups: Chi-square = 28.022, $df$ = 4, $P \leq 0.001$; New England Faculty $N$ = 216, Educators of Prospective Teachers $N$ = 48, College Students $N$ = 695. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.
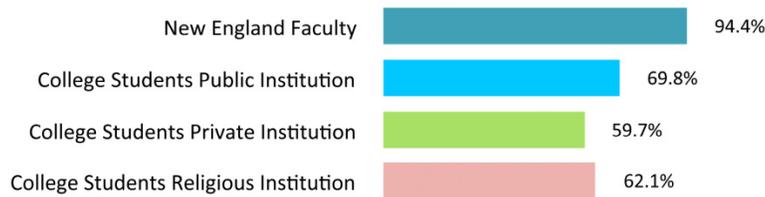
Note that college students enrolled at Public, Private or Religious institutions had comparable levels of open acceptance of evolution among groups, as shown in Figure 9.

## Accept Evolution Openly

New England Faculty — 94.4%
College Students Public Institution — 69.8%
College Students Private Institution — 59.7%
College Students Religious Institution — 62.1%

## Accept Evolution Privately

New England Faculty — 2.8%
College Students Public Institution — 13.8%
College Students Private Institution — 17.6%
College Students Religious Institution — 9.5%

## No Opinion

New England Faculty — 2.8%
College Students Public Institution — 16.3%
College Students Private Institution — 22.7%
College Students Religious Institution — 28.4%

**Figure 9** College Students in the Public, Private or Religious Institutions Have Comparable Levels of Open Acceptance of Evolution (for contrast, the New England Faculty scores are also included). Comparisons among groups: *Chi-square* = 41.326, *df* = 6, $P \leq 0.001$; New England Faculty $N$ = 216, College Students Public Institution $N$ = 116, College Students Private Institution $N$ = 273, College Students Religious Institution $N$ = 169. Adapted from Paz-y-Miño-C G. & Espinosa A. 2011b. New England Faculty And College Students Differ In Their Views About Evolution, Creationism, Intelligent Design, And Religiosity. *Evolution: Education & Outreach* 4: 323–342, with permission.

### College Students: The Contrast Biology Majors versus Non-Majors

Across institutions, either Public, Private or Religious, college biology majors tended to accept evolution more than non-majors (Figure 10). Although creationist views were present among the students (i.e. at least one in every fifteen biology majors and one in every ten non-majors were openly or privately creationists), the "no opinion" choice among the non-majors in the Private and Religious institutions was conspicuous.
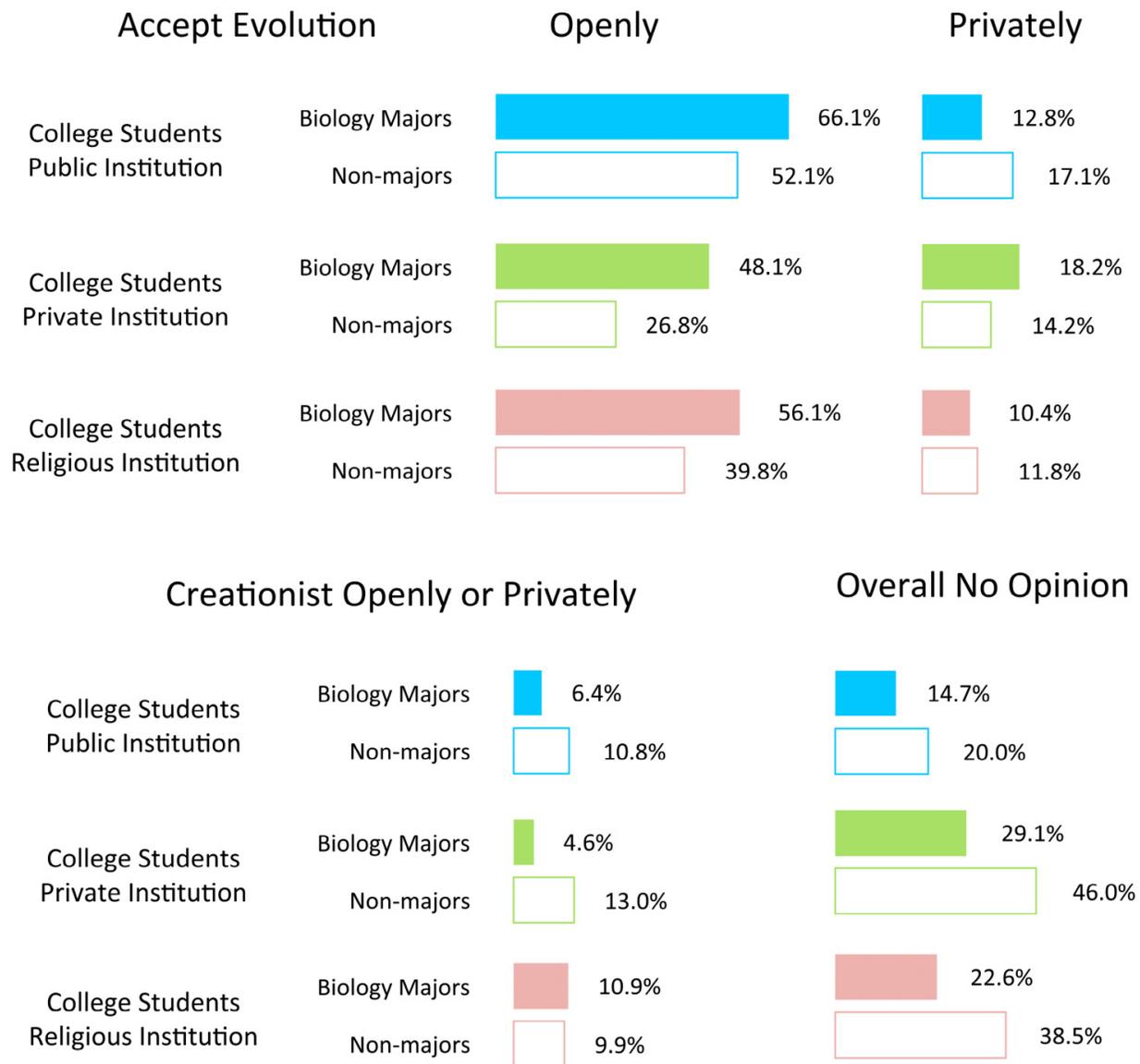
**Figure 10** College Biology Majors Across Institutions (Public, Private or Religious) Tend to Accept Evolution More Than Non-majors; Creationist Views Occur in Low Frequency; "No Opinion" Among the Non-majors in the Private and Religious Institutions Can Be High. Comparisons among groups: Biology Majors versus Non-majors *Chi-square* = 25.192, *df* = 11, *P* = 0.009. College Students Public Institution Biology Majors *N* = 109 and Non-majors *N* = 140, College Students Private Institution Biology Majors *N* = 237 and Non-majors *N* = 239, College Students Religious Institution Biology Majors *N* = 212 and Non Majors *N* = 143. Data Public Institution: this report; data Private and Religious institutions from Paz-y-Miño-C G. & Espinosa A. 2009a. Assessment Of Biology Majors' Versus Non-majors' Views On Evolution, Creationism And Intelligent Design. *Evolution: Education & Outreach* 2: 75–83.

When examining closely the biology majors, it became evident that their acceptance of evolution increased with their academic level, from the Freshman to the Senior years; the "no opinion" position decreased toward graduation (Figure 11). An analogous pattern of steady increase in acceptance of evolution during the four college years was found among the non-majors, but the score at graduation reached 55%, just below the 59% of the general public in New England (data not shown).
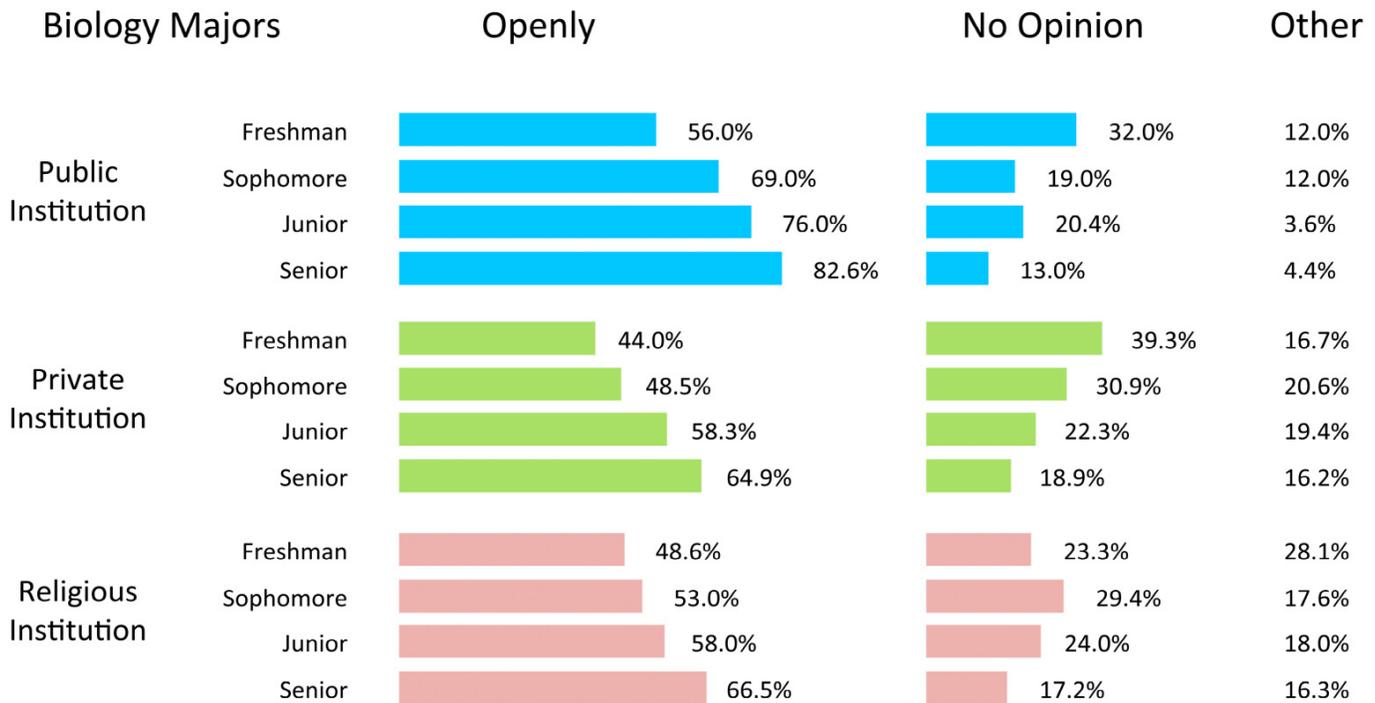
**Figure 11** Acceptance of Evolution Among College Biology Majors Increases With Student Academic Level; the "No Opinion" Position Decreases With Seniority. Comparisons Openly versus No Opinion versus Other: *Chi-square* = 82.591, *df* = 22, *P* ≤ 0.001. Comparison Openly versus No Opinion: *Chi-square* = 42.813, *df* = 11, *P* ≤ 0.001. Comparison mean values Academic Level (Freshman, Sophomore, Junior, Senior) Openly versus No Opinion: *Chi-square* = 9.523, *df* = 3, *P* = 0.023. College Students Public Institution Freshman *N* = 50, Sophomore *N* = 26, Junior *N* = 25, Senior *N* = 23; College Students Private Institution Freshman *N* = 93, Sophomore *N* = 74, Junior *N* = 33, Senior *N* = 37; College Students Religious Institution Freshman *N* = 70, Sophomore *N* = 34, Junior *N* = 50, Senior *N* = 58. The category "Other" includes acceptance of evolution privately, and acceptance of creationism openly or privately. Data Public Institution: this report; data Private and Religious institutions from Paz-y-Miño-C G. & Espinosa A. 2009b. Acceptance Of Evolution Increases With Student Academic Level: A Comparison Between A Secular And A Religious College. *Evolution: Education & Outreach* 2: 655–675.

## The Teaching of Evolution in the Science Class

Most New England Faculty and the majority of Educators of Prospective Teachers and College Students thought that evolution alone should be taught in science classes (Figure 12). "Equal time" to evolution, creationism or Intelligent Design was unpopular among the New England Faculty, but conceivable among the Educators of Prospective Teachers and one in every three College Students supported it.
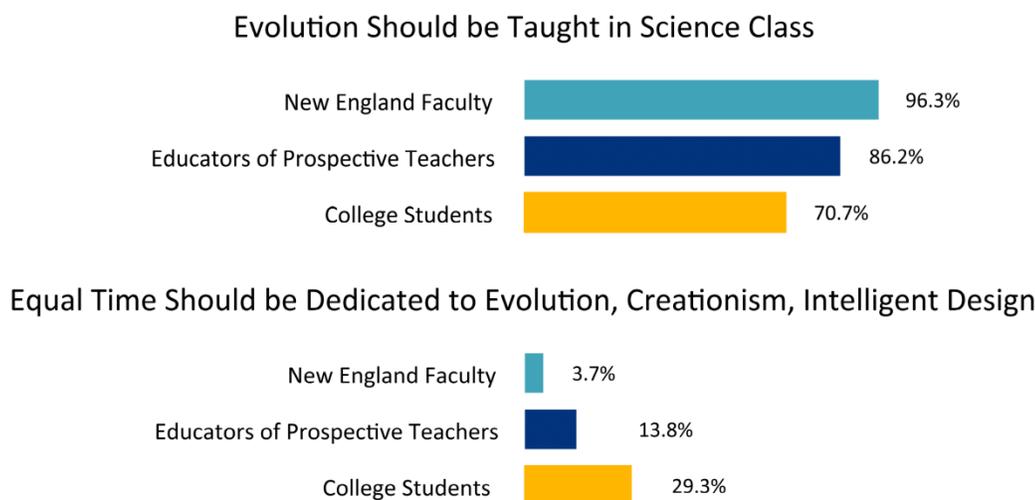


**Figure 12** Most New England Faculty and the Majority of Educators of Prospective Teachers and College Students Support the Exclusive Teaching of Evolution in Science Class. Comparisons among groups: Chi-square = 23.968, *df* = 2, *P* ≤ 0.001; New England Faculty *N* = 241; Educators of Prospective Teachers *N* = 58; College Students *N* = 727. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162 with permission.

Although support to the exclusive teaching of evolution in the science class was comparably high among the College Students at the Public, Private or Religious institutions, the view of dedicating "equal time" to the teaching of evolution, creationism and Intelligent Design was not unusual (Figure 13).
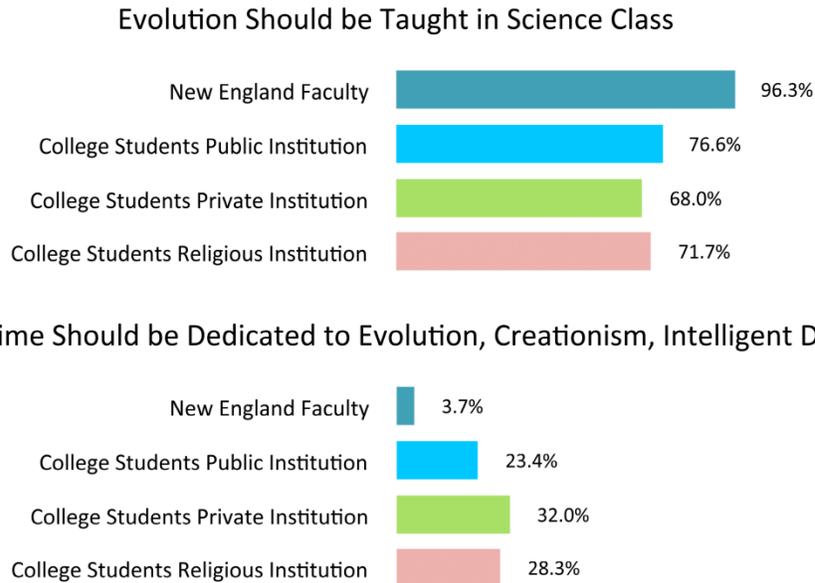
## Evolution Should be Taught in Science Class



## Equal Time Should be Dedicated to Evolution, Creationism, Intelligent Design



**Figure 13** College Students in the Public, Private or Religious Institutions Have Comparable Support to the Exclusive Teaching of Evolution in Science Class. One in Every Four or One in Every Three Students, However, Agree With Dedicating Equal Time to Evolution, Creationism and Intelligent Design (for contrast, the New England Faculty scores are also included). Comparisons among groups: *Chi-square* = 27.072, *df* = 3, *P* ≤ 0.001; New England Faculty *N* = 241, College Students Public Institution *N* = 120, College Students Private Institution *N* = 266, College Students Religious Institution *N* = 173. Adapted from Paz-y-Miño-C G. & Espinosa A. 2011b. New England Faculty And College Students Differ In Their Views About Evolution, Creationism, Intelligent Design, And Religiosity. *Evolution: Education & Outreach* 4: 323–342 with permission.

## Is Evolution Definitely True or Probably True?

More New England Faculty than Educators of Prospective Teachers or College Students thought that evolution is definitely true (Figure 14). The doubtful position, or "probably true," was more common among the College Students than among the Educators of Prospective Teachers or the New England Faculty.

## Evolution is Definitely True
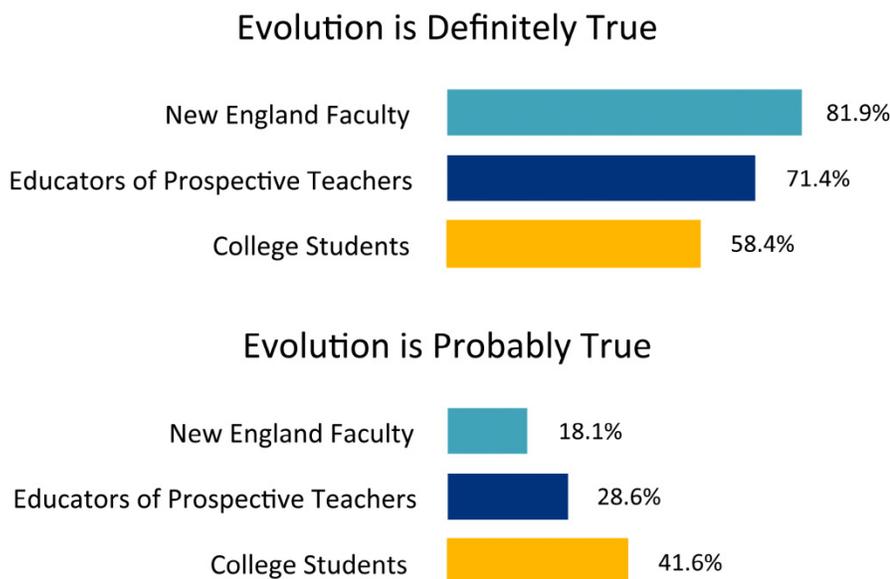


## Evolution is Probably True



**Figure 14** The Majority of New England Faculty, Educators of Prospective Teachers and College Students Think That Evolution is Definitely True Rather Than Probably True. Comparisons among groups: Chi-square = 13.835, *df* = 2, *P* ≤ 0.001; New England Faculty *N* = 216, Educators of Prospective Teachers *N* = 49, College Students *N* = 677. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/ Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162 with permission.

College Students at the Public Institution were more certain that evolution is definitely true than at the Private or Religious institutions (Figure 15). Overall, the doubtful position that evolution is "probably true" was two times more popular among College Students than among the New England Faculty.

## Evolution is Definitely True

New England Faculty — 81.9%
College Students Public Institution — 62.8%
College Students Private Institution — 55.3%
College Students Religious Institution — 54.4%

## Evolution is Probably True

New England Faculty — 18.1%
College Students Public Institution — 37.2%
College Students Private Institution — 44.7%
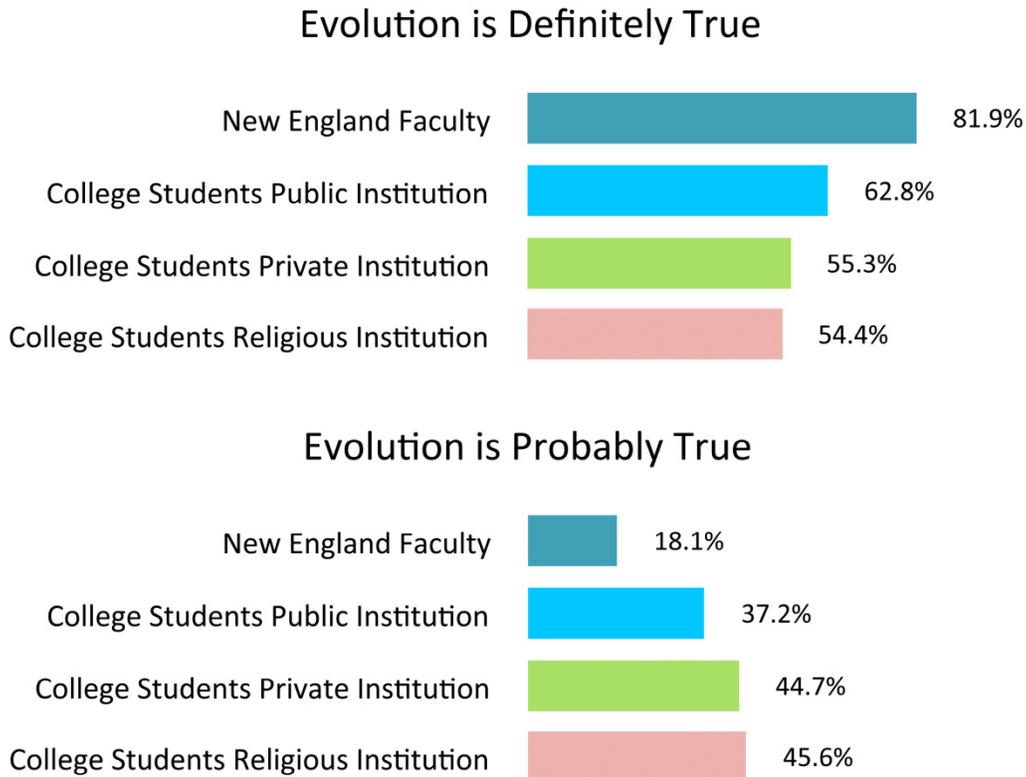College Students Religious Institution — 45.6%

**Figure 15** More College Students in the Public Institution Than in The Private or Religious Institutions Think That Evolution is Definitely True. About Four in Every Ten Students Think Evolution is Probably True (for contrast, the New England Faculty scores are included). Comparisons among groups: *Chi-square* = 21.788, *df* = 3, *P* ≤ 0.001; New England Faculty *N* = 216, College Students Public Institution *N* = 113, College Students Private Institution *N* = 253, College Students Religious Institution *N* = 171. Adapted from Paz-y-Miño-C G. & Espinosa A. 2011b. New England Faculty And College Students Differ In Their Views About Evolution, Creationism, Intelligent Design, And Religiosity. *Evolution: Education & Outreach* 4: 323–342 with permission.

## Reactions to Alternative Definitions of Evolution

There was variation in the views of the New England Faculty versus the Educators of Prospective Teachers versus the College Students about alternative definitions of evolution (Figure 16); note that the definitions below are not necessarily correct, the purpose of using them was to assess preference for considering them true or false:

80% of the New England Faculty, 94.3% of the Educators of Prospective Teachers and 85.1% of the College Students considered definition *A* of evolution as true: *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.* Note that definition *A* was the most comprehensive included in the survey.

11% of the New England Faculty versus 39.6% of the Educators of Prospective Teachers versus 50.3% of the College Students considered definition *B* of evolution as true: *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.* Note that 89% of the New England Faculty, 60.4% of the Educators of Prospective Teachers and 49.7% of the College Students correctly rejected this definition (= the definition implies purpose in evolution and goal toward 'humanity,' which is incorrect).

6% of the New England Faculty versus 13.2% of the Educators of Prospective Teachers versus 25.3% of the College Students considered definition *C* of evolution as true: *gradual process by which monkeys, such as chimpanzees, turn into humans*; the three groups correctly rejected this definition (94% of the general faculty, 86.8% of the educators of prospective teachers and 74.0% of the students considered it false); note that definition *C* wrongly asserts that chimpanzees are 'monkeys' and that humans evolved from them.

30% of the New England Faculty, 34.0% of the Educators of Prospective Teachers and 28.5% of the College Students considered definition *D* of evolution as true: *random process by which life originates, changes, and ends accidentally in complex organisms such as humans*; the three groups correctly rejected this definition (70% of the New England Faculty, 66% of the Educators of Prospective Teachers and 71.5% of the College Students considered it false); note that definition *D* implies that evolution is random and accidental.

30% of the New England Faculty versus 58.5% of the Educators of Prospective Teachers versus 74.8% of the College Students considered definition *E* of evolution as true: *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*; 69% of the New England Faculty versus 41.5% of the Educators of Prospective Teachers versus 25.2% of the College Students correctly rejected this Lamarckian definition; note that the New England Faculty, Educators of Prospective Teachers and College Students true/false responses were distinctive (New England Faculty 31/69% versus Educators of Prospective Teachers 58.5/41.5% versus College Students 74.8/25.2%).
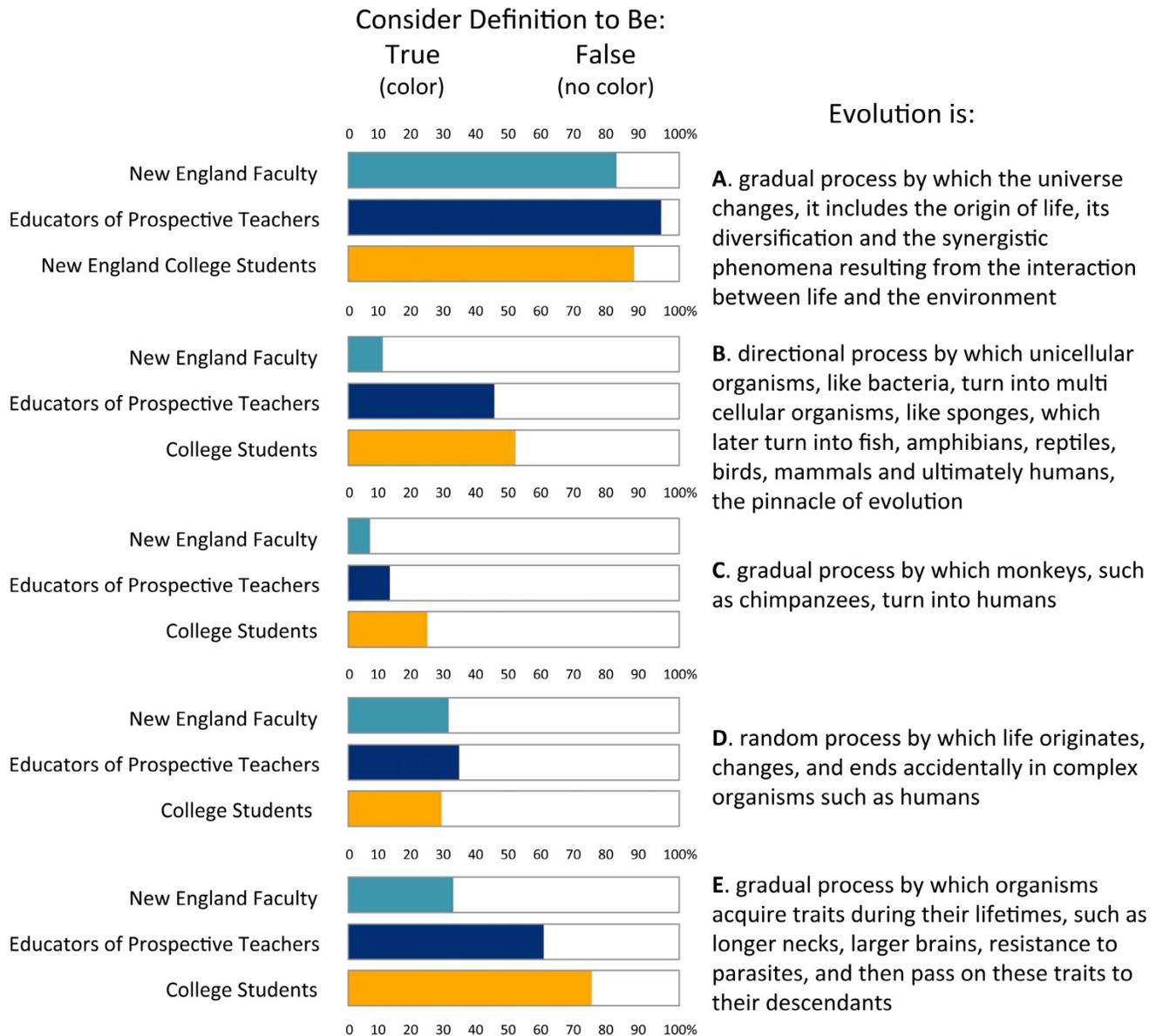


**Figure 16** New England Faculty, Educators of Prospective Teachers and College Students Reactions to Alternative Definitions of Evolution (note that definitions are not necessarily correct). Comparisons within groups: A. Chi-square = 8.532, *df* = 2, *P* = 0.014. B. Chi-square = 36.748, *df* = 2, *P* ≤ 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; New England Faculty *N* = 221, Educators of Prospective Teachers *N* = 53, College Students *N* = 733. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.

Reactions to the alternative definitions of evolution summarized in Figure 16 were also surveyed among the College Students enrolled at Public, Private or Religious institutions and compared to the views of the New England Faculty. The results are shown in Figure 17. The pattern among students was consistent with a group-in-training in the sciences and learning about evolution. The students' misconceptions about evolution were common in comparison to the New England Faculty; Lamarckian views about evolution were two times more frequent among the students than among the faculty.



**Figure 17** Reactions to Alternative Definitions of Evolution as Function of College Students Affiliation: Public, Private or Religious Institutions (note that definitions are not necessarily correct). Comparisons within groups: A. *Chi-square* = 3.827, *df* = 3, *P* = 0.281, B. *Chi-square* = 48.511, *df* = 3, *P* ≤ 0.001, C. *Chi-square* = 23.455, *df* = 3, *P* ≤ 0.001, D. *Chi-square* = 0.291, *df* = 3, *P* = 0.962, E. *Chi-square* = 50.003, *df* = 3, *P* ≤ 0.001; New England Faculty *N* = 221, College Students Public Institution *N* = 161, College Students Private Institution *N* = 223, College Students Religious Institution N = 185. Adapted from Paz-y-Miño-C G. & Espinosa A. 2011b. New England Faculty And College Students Differ In Their Views About Evolution, Creationism, Intelligent Design, And Religiosity. *Evolution: Education & Outreach* 4: 323–342, with permission.
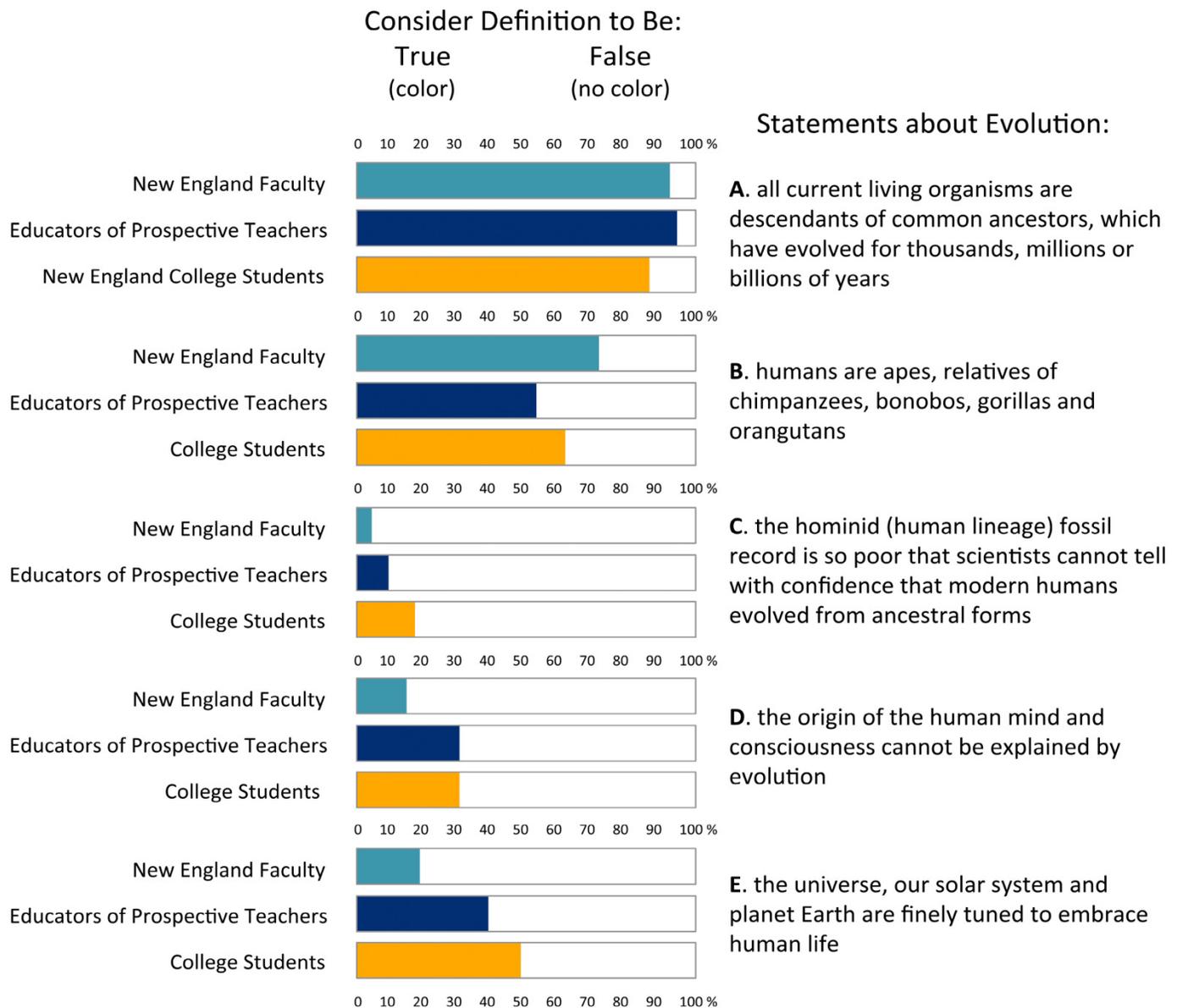
**Figure 18** New England Faculty, Educators of Prospective Teachers and College Students Reactions to Diverse Statements About Evolution (note that statements are not necessarily correct). Comparisons within groups: A. Chi-square = 8.532, $df$ = 2, $P$ = 0.014. B. Chi-square = 36.748, $df$ = 2, $P \leq$ 0.001. C. Chi-square = 14.755, $df$ = 2, $P \leq$ 0.001. D. Chi-square = 0.655, $df$ = 2, $P$ = 0.721. E. *Chi-square* = 40.081, $df$ = 2, $P \leq$ 0.001; New England Faculty $N$ = 221, Educators of Prospective Teachers $N$ = 53, College Students $N$ = 733. Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.

## Views about the Evidence Supporting the Evolutionary Process

The New England Faculty, Educators of Prospective Teachers and College Students varied in their understanding of how evolution works (Figure 18), note that the statements below are not necessarily correct; the purpose of using them was to assess preference for considering them true or false:

94% of the New England Faculty, 96.2% of the Educators of Prospective Teachers, and 88.2% of the College Students correctly considered statement *A* as true: *all current living organisms are descendants of common ancestors, which have evolved for thousands, millions or billions of years.*

74% of the New England Faculty versus 54.7% of the Educators of Prospective Teachers versus 65.4% of the College Students correctly considered statement *B* as true: *humans are apes, relatives of chimpanzees, bonobos, gorillas and orangutans.*

4% of the New England Faculty versus 11.3% of the Educators of Prospective Teachers versus 18.7% of the College Students considered statement *C* as true: *the hominid (human lineage) fossil record is so poor that scientists cannot tell with confidence that modern humans evolved from ancestral forms*; note that 96% of the New England Faculty, 88.7% of the Educators of Prospective Teachers, and 81.3% of the College Students correctly rejected this statement.

15% of the New England Faculty versus 32.0% of the Educators of Prospective Teachers versus 34.7% of the College Students considered statement *D* as true: *the origin of the human mind and consciousness cannot be explained by evolution*; note that 85% of the New England Faculty, 68% of the Educators of Prospective Teachers, and 65.3% of the College Students correctly rejected this statement.

21% of the New England Faculty versus 41.5% of the Educators of Prospective Teachers versus 47.3% of the College Students considered statement *E* as true: *the universe, our solar system and planet Earth are finely tuned to embrace human life*; note that 79% of the New England Faculty, 58.5% of the Educators of Prospective Teachers, and 52.7% of the College Students correctly rejected this statement.

## SUMMARY OF RESULTS

1) Understanding of science and acceptance of evolution decreased with increasing religiosity in all groups (= negative association of variables). Acceptance of evolution increased with higher levels of understanding science (= positive association of variables). The non-religious responders reached the highest levels of understanding science and evolution in contrast to the deeply-religious who scored lowest in the Science (*SI*) and Evolution (*EI*) indexes.

2) The New England Faculty scored high in science and evolution literacy and low in religiosity; the Educators of Prospective Teachers scored intermediate in science and evolution literacy as well as in religiosity; and the College Students (a population still in-training) scored low in science and evolution literacy and high in religiosity.

3) Most New England Faculty accepted evolution openly, followed by the majority of Educators of Prospective Teachers and College Students. Private acceptance of evolution was rare among the New England Faculty but noticeable among the Educators of Prospective Teachers and the College Students. At least one in ten Educators of Prospective Teachers and one in five College students preferred to not express an opinion concerning acceptance of evolution either openly or privately, a rare view among the New England Faculty.

4) Among College Students from either Public, Private or Religious institutions, the biology majors were more inclined to accept evolution than the non-majors. Acceptance of evolution among the biology majors increased conspicuously with academic level, from the Freshman to the Senior years. At least one in every fifteen biology majors and one in every ten non-majors were openly or privately creationists.

5) Most New England Faculty and the majority of Educators of Prospective Teachers and College Students thought that evolution alone should be taught in science classes. "Equal time" to evolution, creationism or Intelligent Design was unpopular among the New England Faculty, but conceivable among the Educators of Prospective Teachers and one in every three College Students supported it.

6) More New England Faculty than Educators of Prospective Teachers or College Students thought that evolution is definitely true. The doubtful position, or "probably true," was more common among the College Students than among the Educators of Prospective Teachers or the New England Faculty.

7) One in every three New England Faculty, two in every three Educators of Prospective Teachers, and three in every four College Students had a Lamarckian understanding of the evolutionary process (i.e. believed that organisms acquire traits during their lifetimes, such as longer necks, larger brains, resistance to parasites, and then pass on these traits to their descendants –which is a pervasive cultural misconception).

8) One in every four New England Faculty, one in every two Educators of Prospective Teachers and one in every three College Students did not know that humans are apes, relatives of chimpanzees, bonobos, gorillas and orangutans.

9) One in every seven New England Faculty, one in every three Educators of Prospective Teachers and College Students did not know that the origin of the human mind and consciousness can indeed be explained by evolution.

10) One in every five New England Faculty, two in every five Educators of Prospective Teachers and one in every two College Students thought incorrectly that the universe, our solar system and planet Earth are finely tuned to embrace human life.

## CONCLUSIONS AND IMPLICATIONS OF THE RESULTS

The assumption that in the ideologically progressive and highly educated Northeastern US the research professors, educators of prospective teachers and their college students are consistently supportive of science/evolution, and remain distant from belief-based perspectives about the natural world, is partially illusory and requires careful examination:

1) Public acceptance of evolution in New England –although the highest in the US— is only 59%, which suggests that the education system, and specifically here, college education is not fully effective in communicating the reality of evolution to the New England students (= the soon-to-be the "regional public"). Only biology major students seem to receive strong education in matters of evolution. Biology majors are the only student population surpassing the regional level (59%) of acceptance of evolution at the time of graduation, but what is accomplished is insufficient; based on our samples, only 82.6% of the graduates from the Public, 64.9% from the Private, and 66.5% from the Religious institutions accepted evolution openly.

2) Although the professors at the New England colleges and universities showed high levels of understanding science and acceptance of evolution, their colleagues specialized in training future teachers (i.e. the Educators of Prospective Teachers) consistently hesitated to embrace evolution and scored below in science/evolution and above in religiosity when compared to the non-educators faculty (i.e. 41.5% of the Educators of Prospective Teachers versus 29.0% of the New England Faculty –still a surprisingly high score— considered religion to be *very important in their lives*!). Because we assume that the PhD- or doctoral-training levels in *pedagogy* (= specialization of the Educators of Prospective Teachers) or in *other academic fields* (= what we called here the "New England Faculty") are analogously rigorous in the US, we conclude that the hesitation to fully embrace evolution by the Educators of Prospective Teachers is inherent to their deficient understanding of science/evolution and high religiosity. Although differences in attitudes toward evolution by professors in diverse fields and geographic regions of the US are conceivable, our sample of the New England Faculty generated unambiguous responses (e.g. 94.4/2.8% open/private acceptance of evolution and 2.8% no opinion) in contrast to the cautious views held by the Educators of Prospective Teachers (75.0/12.5% open/private acceptance of evolution and 12.5% no opinion).

3) Our findings are consistent with the hypothesis that the controversy over science/evolution and creationism is inherent to the incompatibility between scientific rationalism/empiricism and the belief in supernatural causation. The negative association of variables in all analyses between level of religiosity and level of understanding science/evolution, and the positive association between science literacy and evolution literacy support the hypothesis. Long-term harmonious coexistence between science/evolution and creationism –and all its forms, see Definitions above— is illusory. Societies will struggle indefinitely with this incompatibility, therefore the interaction between science/evolution and religiosity is destined to fluctuate historically between intense and moderate antagonism.

## RECOMMENDATIONS TO ADDRESS THE "COLLEGE STUDENTS" PROBLEM

### *What Can be Done to Communicate the Reality of Evolution to College Students?*

1) Discuss evolution as fact. Refute the idea that evolution is hypothetical. Emphasize that the *Theory of Evolution* ("Theory" as in science) is unequivocally supported by all evidence.

2) Discuss human evolution –in all science classes, speeches, conversations— from the molecular, morphological and cognitive perspectives and provide compelling examples of evolution in the human genome that place *Homo* within the apes and other primates, e.g. mosaic structure of genetic variation and genetic distances between modern humans and extinct Neanderthals in respect to other living apes (chimpanzee/bonobo, gorilla, orangutan), origin of chromosome 2 by fusion of two ancestral chromosomes after the split of the human and chimpanzee/bonobo lineages, or diversification of the beta cluster of hemoglobin genes in Old and New World primates.

3) Reveal the pattern of nervous systems' diversity across taxa by comparing/contrasting the human brain with the neurobiology/cognition of animals; reject the fallacy of the "uniqueness of the human brain" by comparatively examining the emergence of simpler-to-more-complex forms of intelligence in non-human taxa.

4) Illustrate the correlation between geographic distribution of human genetic polymorphisms, blood types, and spoken-language evolution. Highlight the importance of the genetic clues inherent to the origins, history and migration patterns of indigenous peoples worldwide –evidence of evolution at work in human lineages.

5) Emphasize that micro-evolution (change in the genetic makeup of populations) and macro-evolution (speciation and the development of major processes and patterns in nature) are interdependent and that one cannot occur without the other.

6) Remark on the molecular unity of life and link all organisms to a common ancestor by using phylogenetic analyses based on DNA/RNA and their products.

7) Take advantage of the public current fascination with fossils, particularly dinosaurs and hominids, and use them to illustrate adaptive radiation, speciation and extinctions of formerly successful taxa.

8) Conduct field excursions to exemplar environments where geologic time can be appreciated at large scale, i.e. Grand Canyon, or the Hawaiian or Galapagos archipelagos, or simply a safe highway shoulder with access to geological layers.

9) Discuss novel examples of micro-evolution (tuberculosis resistance to antibiotics; mutation rate associated with drug resistance in malaria pathogens; fast mutation rate in influenza viruses) and macro-evolution (malaria host switching and *Plasmodium* diversification; beak evolution in Darwin's finches) currently at work.

10) Leave the audience with the idea that evolution is a gradual process by which the universe changes and that it includes the origin of life, its diversification, and the synergistic phenomena resulting from the interaction between life and the environment. Reject the fallacy of "fine tuning" (= the notion that the universe, our solar system and Earth were designed to fit us –it is life which has evolved adaptively in response to environmental constrains and the natural laws of the universe). The reality of evolution continues to exist regardless of our awareness and level of understanding of it.

<div style="text-align: right">Adapted from: Paz-y-Miño-C G. & Espinosa A. 2009b. Acceptance of Evolution Increases with Student Academic Level: A Comparison Between a Secular and a Religious College. *Evolution: Education & Outreach* 2: 655–675.</div>

## RECOMMENDATIONS TO ADDRESS THE "EDUCATORS OF PROSPECTIVE TEACHERS" PROBLEM

### *How Can Educators of Prospective Teachers Strengthen Their Own Science and Evolution Literacy?*

1) Apply *equal rigor* to the training in pedagogy and science/evolution; the educators of prospective teachers should reach comparable levels of understanding science/evolution and accepting evolution to those of the non-educator professors.

2) Dialog with the science faculty at their own institutions and concur to fortify the on-the-job- science/evolution training of the educators of prospective teachers, as well as of the students enrolled in education programs. The ubiquitous disconnect between the education departments and the rest of the academic fields at the US colleges and universities is concerning, and it requires immediate approach between the educators and the general faculty.

3) Educate themselves about the "antievolution wars" and participate decisively in the pro-teaching-of evolution movement. It is crucial that the educators of prospective teachers lead the institutional (their own colleges and universities), regional and national strategies to secure proper science/evolution education among the prospective teachers who earn degrees under their guidance. As university professors, the educators of prospective teachers are less vulnerable to institutional or societal reprisal for leading the teaching of evolution than their academic progeny of young teachers. The educators of future educators are as responsible for sponsoring proper science/evolution training to the prospective teachers as the latter are of acquiring and communicating that knowledge to their students.

4) Study the legal protection that guarantees proper science/evolution education at all academic levels and make this information available to the prospective teachers as part of their regular training.

5) Implement curricular reform at their education departments and institutions to fortify science training of prospective teachers. Higher-education programs in science, particularly biology, are fundamental to integrate evolution into the academic backgrounds of prospective teachers.

6) Poll in-campus variations in attitudes toward science and evolution among the educators of future educators, the prospective teachers they mentor, and the general faculty, and coordinate immediate responses to the emerging antievolutionism in the US campuses.

7) Co-sponsor with the general faculty in- and off- campus lecture series, workshops and debates to examine the antievolution phenomena, learn about the obstacles raised by schools boards on the science school curriculum and orient other educators of future educators and prospective teachers on how to communicate modern science to all. Workshop-discussion modules on *why evolution matters* can be particularly effective when organized for educators of future educators and prospective teachers.

8) Pursue participation in- and organization of *'town halls for scientists and public'* to discuss issues related to scientific research and the controversy evolution versus creationism and all its forms, including Intelligent Design, Theistic Evolution, and Creation Science.

9) Participate in and sponsor multidisciplinary conferences (anthropology, biology, education, ethics, history, law, philosophy, political science, social psychology, religious studies) committed to advice community groups on theoretical and practical aspects of civil action to counter antievolution campaigns, anti-intellectualism tendencies, and pro creationism agendas.

10) Monitor the antievolution movements that grow strong among misinformed citizens, vary in impact geographically, and benefit from the disconnect between highly-educated audiences, like educators of prospective teachers/general faculty, and society. The educators of prospective teachers must take the lead in conceptualizing and strategizing the civil discourse and societal action to ensure internationally competitive science/evolution literacy in the US.

Adapted from Paz-y-Miño-C G. & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162.

## RECOMMENDATIONS TO ADDRESS THE "PROFESSORS" PROBLEM

### *How Can Highly Educated Professors Contribute to Disseminate Evolution Literacy?*

1) By being proactive rather than reactive in confronting the 'anti-evolution wars'. It is imperative that the university professors outreach the public and lead the debate over science education and evolution literacy.

2) By persuading the education departments at their institutions to fortify science training of future educators. Higher-education and outreach programs in science, particularly biology, for school teachers are fundamental to integrate evolution into our society's culture.

3) By changing the emphasis with which college science is taught and improving the science curriculum. It is easier and faster to change the perspectives with which a course is taught than to modify the university/college curriculum; however, both are indispensable to improve positive attitudes toward science and evolution. Due to the disparity in acceptance of evolution between biology majors and non-majors, evolutionary theory should be offered widely and taught without distinction between biology majors and non-majors as part of their science literacy.

4) By creating a new type of professorship position: *'professor for the public understanding of science,'* whose exclusive role shall be to explain to the public the significance of the research conducted by each discipline, and also by assigning the most reputable professors and best communicators of science to the large-lecture courses, usually attended by non-science majors.

5) By constantly surveying variations in attitudes toward science and evolution among faculty, students and university/college staff, and coordinating immediate responses to emerging antievolutionism.

6) By sponsoring in- and off- campus lecture series, workshops and debates, open to the local high-school teachers and the public, where university professors of all disciplines examine the antievolution phenomena, learn about the limitations established by schools boards on the science school curriculum and orient the audience on how to communicate modern science to all. Workshop-discussion modules on 'why evolution matters' can be particularly effective when organized for school board members, school district administrators, science teachers and university professors.

7) By actively pursuing participation in *'town halls for scientists and public'* to discuss issues related to scientific research and the controversy evolution versus creationism and all its forms, including Intelligent Design, Theistic Evolution, and Creation Science.

8) By organizing multidisciplinary teams of professors (anthropology, biology, education, ethics, history, law, philosophy, political science, social psychology, religious studies) committed to advice community groups on theoretical and practical aspects of civil action to counter antievolution campaigns, anti-intellectualism tendencies, and pro creationism agendas.

9) By never underestimating the influence of the antievolution movements that grow strong among misinformed citizens, vary in impact geographically, and benefit from the frequent disconnect between scientists and society.

10) By including in the 'broad impact' section of research grant applications specific multi-disciplinary modules to outreach educators and the public in the areas of scientific literacy, 'on-the-job-training' workshops for local/regional high school teachers, online-mini courses, online assessment of local/regional attitudes toward science/evolution, laboratory internships and field work.

<div align="right">Adapted from Paz-y-Miño-C G. & Espinosa A. 2011b. New England Faculty and College Students Differ in Their Views About Evolution, Creationism, Intelligent Design, and Religiosity. <i>Evolution: Education & Outreach</i> 4: 323–342.</div>

## METHODS

### The Faculty and Students Samples

**Faculty**  We sampled New England Faculty and Educators of Prospective Teachers affiliated with 35 academic institutions (17 colleges, 18 universities) which were widely distributed geographically in all New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont; Tables 1 and 2, for institutional details see Table 3). In each state, we selected two public secular, two private secular and two religious colleges and/or universities, except for Maine where only one religious institution was identified (Table 3). We contacted via email (addresses obtained from institutional websites) 992 general faculty according to two criteria: first, members of the biology departments, or close equivalents (e.g. ecology and evolutionary biology, molecular and cell biology, natural sciences), of each institution (regardless of sex), who are usually highly educated in evolution; and second, a similar number of non-biology faculty, across 40 different disciplines, who were selected randomly (sex ratio 1:1; Table 3). We also contacted via email (same as in above) 506 Educators of Prospective Teachers 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 (Tables 1 and 2, for statistical details see Table 3).

**Students**  To compare the views of both the New England Faculty and the Educators of Prospective Teachers with those of College Students, we surveyed students from four representative New England institutions (email requests to all enrolled students $N$ = 17,621): Public secular University of Massachusetts Dartmouth (UMassD $N$ = 7,982 students contacted), Private secular Roger Williams University (RWU $N$ = 3,806), Religious I Providence College (PC I $N$ = 3,910), and Religious II Salve Regina University (SRU II $N$ = 1,923)(for summary of students profiles see Table 2; for detailed profiles of students and their institutions see Table 4). Because the student population from the public secular institution was particularly large (45.3% of all students), we included one private (Private) and two religious institutions (Religious I and Religious II) to improve the representation of both *public* versus *private* and *secular* versus *religious* student profiles in respect to the profiles of the New England Faculty and the Educators of Prospective Teachers, as follows:

1) New England Faculty and Educators of Prospective Teachers contacted: 33.3% Public versus 66.7% Private; College Students contacted: 45.3% Public versus 54.7% Private; and

2) New England Faculty and Educators of Prospective Teachers contacted: 66.7% secular versus 33.3% religious; College Students contacted: 66.9% secular versus 33.1% religious (percentages generated from Tables 3 and 4).

**Groups Profiles**  The New England Faculty, Educators of Prospective Teachers, and College Students profiles of those who responded to the survey were comparable in respect to residency and workplace location (New England states), but differed, as we expected, in respect to place of birth (New England Faculty usually belong to diverse cultural backgrounds: New England 42.6%, East Coast  17.6%, other states 27.5%, foreign countries 12.3%; Educators of Prospective Teachers, as faculty themselves, also belonged to diverse cultural backgrounds: New England 40.3%, East Coast  24.2%, other states 33.9%, foreign countries 1.6%; and College Students mean Public + Private + Religious I + Religious II: New England 76.2%, East Coast 15.0%, other states 6.0%, foreign countries 2.8%; Table 2) and level of education (New England Faculty: PhD holders 90.2%, doctoral degree or equivalent 2.9%, and masters degree 6.9%; Educators of Prospective Teachers: PhD holders 79.0%, doctoral degree or equivalent 8.1%, Masters degree 9.7%; and Bachelors degree 3.2%; and College Students mean Public + Private + Religious I + Religious II: Freshman 25.8%, Sophomore 23.2%, Junior 22.0%, and senior 29.0%; Table 2).

### The Online Survey

One thousand one hundred and thirty three New England Faculty ($N$ = 244, 21.5%), Educators of Prospective Teachers ($N$ = 62, 5.5%), and College Students ($N$ = 827, 73.0%) responded to a 30-question anonymous and voluntary online survey

(procedures developed by Paz-y-Miño-C & Espinosa 2009a, b, 2011b) to assess their views about evolution, creationism and Intelligent Design, as well as about their understanding of how science and the evolutionary process work, and their personal convictions concerning the evolution and/or creation of humans in the context of their religiosity (note that below we summarize only six questions relevant to this article). The level of understanding of science was assessed by asking three sub-questions included in the 30 questions in the survey (same as in Paz-y-Miño-C & Espinosa 2011b).

All participants were free to withdraw from the survey at any time; no risks or discomfort were involved in the study. The Institutional Review Board of the University of Massachusetts Dartmouth (UMassD) approved the New England Faculty (surveyed during the first week of April and third week of May 2010), the Educators of Prospective Teachers (fourth week of March and first week of April 2011) and UMassD students' study (second week of September 2009), and the Human Subjects / Institutional Review Boards of Roger Williams University (third week of October 2009), Providence College (third week of April 2009), and Salve Regina University (fourth week of April 2011) approved the surveying of their own students.

All participants answered questions 1-6 (but see exception in question 5, below) in order and were instructed to not skip or go back to previous questions to fix and/or compare answers. Questions 1, 2, 3 had five (a, b, c, d, e) choices per question; questions 4-6 were true/false and had five (a, b, c, d, e) or three (a, b, c) subcomponents (= each true/false), respectively. All choices per question, including the true/false options, were presented randomly and only one choice was possible per question, except for questions 4-6 that allowed responders to select true or false in each of the subcomponents (i.e. questions 4-5: true/false for a or b or c or d or e; question 6: true/false for a or b or c). For the purpose of reporting the data in this article and matching the description of each question with the figure legends, here we state the questions as follows (similar to Paz-y-Miño-C & Espinosa 2009a, b, 2011b):

## Questions Addressing Views about Evolution, Creationism, and Intelligent Design

**Question 1**  Evolution, creationism and Intelligent Design in the science class. Which of the following explanations about the origin and development of life on Earth should be taught in science classes? A = evolution, B = equal time to evolution, creationism, intelligent design, C = creationism, D = intelligent design, E = do not know enough to say.

**Question 2**  Your willingness to discuss evolution. Select the statement that describes you best: A = I accept evolution and express it openly regardless of other's opinions, B = no opinion, C = I accept evolution but do not discuss it openly to avoid conflicts with friends and family, D = I believe in creationism and express it openly regardless of others' opinions, E = I believe in creationism but do not discuss it openly to avoid conflicts with friends and family.

**Question 3**  Your overall opinion about evolution. Select the statement with which you agree most about *'evolution is'*: A = definitely true, B = probably true, C = definitely false, D = probably false, E = do not know enough to say.

## Questions Addressing Views about the Evolutionary Process

**Question 4**  An acceptable definition of evolution. Indicate if each of the following definitions of evolution is either true or false: 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, 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.

**Question 5**  Evidence about the evolutionary process. Indicate if each of the following statements about evolution is either true or false: 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, D = 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, E = the universe, our solar system and planet Earth are finely tuned to embrace human life.

## Question Addressing Responders' Religiosity

**Question 6**  Your religiosity. Indicate if each of the following statements about religiosity is either true or false, select all that apply: A = faith in God is necessary for morality, B = religion is very important in my life, C = I pray at least once a day.

## Understanding-of-Science-, Evolution- and Religiosity Indexes

The Pew Global Attitudes Project (2007) has used the three choices of Question 6 (above) to generate a *Religiosity Index* (*RI*), a powerful predictor of religious views worldwide (47 countries), which we applied to our New England Faculty, Educators of Prospective Teachers, and College Students samples. *RI* ranges from 0 to 3 (least to most religious): +1 if responders believe that *faith in God is necessary for morality*, +1 if *religion is very important in their lives*, and +1 if *they pray daily*.

To account for the levels of understanding of science and the evolutionary process, we generated two descriptive indexes (*Science Index SI*, *Evolution Index EI*, similar to Paz-y-Miño-C & Espinosa 2011b), analogous to *RI* (above). Thus, we could compare levels of understanding of science (*SI*) and evolution (*EI*) with level of religiosity (*RI*). Note that, in previous studies, we have determined that these three interacting factors are associated with an individual's acceptance of evolution (Paz-y-Miño-C & Espinosa 2012a, b, 2013). Our *SI* and *EI* range from 0 to 3 (lower to higher levels of understanding of science and evolution) and rely on three questions each, which were selected from a pool of five questions about science and ten about evolution (all part of the 30-questions in the entire online survey); the suitable questions for each index showed variability between the responses by the New England Faculty, the Educators of Prospective Teachers, and the College Students, and were, therefore, informative to discriminate among the three groups: *SI* +1 if responders 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 non-scientific 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*; *EI* +1 if responders 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*.

## Statistical Analyses

For the five-choice questions (1, 2, 3), we compared the New England Faculty (NE Fac) versus the Educators of Prospective Teachers (Edu) versus the College Students from four types of academic institutions (Stu: Public + Private + Religious I + Religious II) and analyzed separately the data generated in each of the questions (i.e. Questions 1, 2 or 3; choices a, b, c, d or e). Data from each question were organized in contingency tables, for example, *NE Fac, Edu, Stu x a, b, c, d, e* (Chi-square tests, null hypotheses rejected at $P \leq 0.05$). When questions had none or very few responders (< 5%, note that Chi-square analyses are inaccurate when over 20% of the expected values are less than 5, Siegel & Castellan 1988) in one, two or three of their choices, we eliminated such choices and adjusted the contingency tables accordingly for the remaining number of choices per sample group.

For the true/false questions 4-6, we organized the data corresponding to each subcomponent of the question (Questions 4-5: subcomponents a, b, c, d, e; Question 6: subcomponents a, b, c) in separate 2×3 contingency tables per each of the five or three subcomponents per question, respectively. For example, Questions 4-5, subcomponents a or b or c or d or e (each separately): *True, False x NE Fac, Edu, Stu,* and Question 6, subcomponents a or b or c (each separately): *True, False x NE Fac, Edu, Stu,* (Chi-square tests, null hypotheses rejected at $P \leq 0.05$). Note that for Question 5 we could only sample students from the Religious II institution (SRU Rel II), thus we compared New England Faculty versus Educators of Prospective Teachers versus the compiled data of College Students from three institutions: Public + Private + Religious II.

Although we instructed participants to not skip questions, they could do it freely (= Human Subjects / Institutional Review Boards' policies, above); therefore, the total number of New England Faculty, Educators of Prospective Teachers or College Students responders per question varied, as reported in the figure captions. The science- (*SI*), evolution- (*EI*) and religiosity- (*RI*) indexes did range from 0 to 3 each; we generated them for the New England Faculty, the Educators of Prospective Teachers, and the College Students, and analyzed the raw data of each index separately as function of subpopulation (i.e. *SI*: NE Fac versus Edu versus Stu, *EI*: NE Fac versus Edu versus Stu, and *RI*: NE Fac versus Edu versus Stu) with Kruskal-Wallis one-way ANOVA on ranks (null hypotheses rejected at $P \leq 0.05$). For pair wise comparisons (i.e. when contrasting Indexes scores between groups, as in page 4: *RI in the Context of Northeastern US, North America, the World*), we used Dunn-test two-tail, null hypotheses rejected at $P \leq 0.05$. Linear regression was used to analyze the association between the 0-to-3 levels of: *SI* (dependent variable) versus *RI* (independent variable), or *EI* (dependent variable) versus *RI* (independent variable), or *EI* (dependent variable) versus *SI* (independent variable) within each of the subpopulations (i.e. NE 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 variable) and level of understanding of science (independent variable), we used one-tail tests to reject null hypotheses at $P \leq 0.05$.

## Survey Response Rates

**New England 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 (summary in Table 1, details in Table 3), a response rate comparable to analogous email/online studies (= 24%, The Pew Research Center For The People & The Press 2009). The average number of New England Faculty contacted per state was 165 (*r* = 142–215) and the average percent of responders 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) completed the survey (summary in Table 1, details in Table 3), a lower response rate than the general faculty (above) but consistent with the parameters of sample representativeness and statistical 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 & Plutzer 2011), but rather to demographic segmentation and low variance in responses (van Bennekom 2002), as in our studies. The average number of educators of prospective teachers contacted per state was 84 (*r* = 54–153, Table 1) and the average percent of responders per state was 12 (*r* = 7.2–16.4, Table 1). Of all responders (*N* = 62), 59.7% were females and 40.3% were males (Table 1).

**College Students**  Eight hundred and twenty seven (4.7%) of the 17,621 students contacted to participate in the study completed the survey (summary in Table 2, details in Table 4). Response rate by students varied among institutions: Public 161 (2.0% of the 7,982 contacted), Private 298 (7.8% of the 3,806 contacted), Religious I 185 (4.7% of the 3,910 contacted), and Religious II 183 (9.5% of the 1,923 contacted)(summary in Table 2, details in Table 4); these values were consistent with previous online sampling of these institutions where the demographic profile of participants in the surveys resembled closely the institutional profiles (Paz-y-Miño-C & Espinosa 2009a, b, 2011b). Of all responders (*N* = 827), 61.5% were females and 38.5% were males (Tables 2 and 4).

## Representativeness of the Samples and Statistical Confidence

We consider our samples statistically representative of the New England Faculty, Educators of Prospective Teachers, and College Students for the following reasons:

1) The demographic segmentation of responders (= percent of responders per state and type of institution as function of the segmentation of those contacted) was in accordance with the demographics of the entire populations participating in the study (Tables 1-4); note that the response rate per state as function of those completing the survey was statistically similar between NE Fac and Edu (*Chi-square* = 2.150, *df* = 5, *P* = 0.828, data extracted from Table 1), as well as the NE Fac and Edu demographic profiles for New England, East Coast, and other states in the US (*Chi-square* = 1.116, *df* = 2, *P* = 0.572, data extracted from Table 2), but not when foreign countries were included in the comparison (*Chi-square* = 8.648, *df* = 3, *P* = 0.034, data extracted from Table 2) due to the rareness of international faculty (1.6%) among the educators of prospective teachers, the latter did not skew the pattern of responses. The students' demographic profiles closely matched those of the entire student populations at their institutions, as well as their New England (76.2%) and East Coast (15%) upbringing (Tables 2 and 4); their responses were, therefore, pooled in a *single group of students* (Table 2) to homogenize their public-, private- secular or religious backgrounds, thus matching the students' profiles with those of the general faculty and the educators' (note that independent analysis of New England student views about evolution have been published; Paz-y-Miño-C & Espinosa 2009a, b, 2011b).

2) The responses were tightly clustered (low variance is associated with satisfactory accuracy, see van Bennekom 2002) in each sample of NE Fac, Edu and Stu that we used to generate the science index *SI* (variance: *NE Fac* = 0.495, *Edu* = 1.036, and *Stu* = 0.910), evolution index *EI* (variance: *NE Fac* = 0.431, *Edu* = 0.729, and *Stu* = 0.682), and religiosity index *RI* (variance: *NE Fac* = 0.703, *Edu* = 1.028, and *Stu* = 1.190), from which we drew broad conclusions about acceptance of evolution in the context of the responders' understanding of science/evolution and level of religiosity.

3) The margin of error per sample at 95% certainty and 50% response distribution was consistent with conventional polling of public opinions of variable sizes (see van Bennekom 2002), as follows: *NE Fac* ± 5.5%, *Edu* ± 11.7%, and *Stu* ± 3.3% (sample size calculator Raosoft 2011); note that by mentally adding and/or subtracting the margin of error values to/from the percentile responses in each question (data in Figures) the differential response pattern between NE Fac, Edu and Stu persists.

4) The New England Faculty, Educators of Prospective Teachers, and College Students held consistently *high*, *middle* and *low* percentile levels of agreement/disagreement, respectively, in each of the survey questions.

5) The response rates of the New England Faculty (24.6%), Educators of Prospective Teachers (12.3%), and College Students (4.7%), in respect to the total populations contacted, were analogous to comparable studies of public opinions in

the US (The Pew Research Center For The People & The Press 2009) and consistent with our previous studies (Paz-y-Miño-C & Espinosa 2009a, b, 2011b); note observation about modern views on surveys validity based on response rates (above).

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* A comprehensive list of references about the controversy science/evolution versus creationism is discussed and/or available in the Paz-y-Miño-C & Espinosa publications.

**Table 1** Descriptive statistics of the New England Faculty and Educators of Prospective Teachers sampled per New England state

Adapted from Paz-y-Miño-C G & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.

| State[a] | New England Faculty[b] | | | | | | | Educators of Prospective Teachers[c] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Connecticut (CT) Sub Total | 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] |
| Maine (ME) Sub Total | 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] |
| Massachusetts (MA) Sub Total | 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] |
| New Hampshire (NH) Sub Total | 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] |
| Rhode Island (RI) Sub Total | 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] |
| Vermont (VT) Sub Total | 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] |
| Unidentified state | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7 | NA | NA | 11.3[e] |
| Grand Totals | 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] | |

[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 3

[b] New England 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 3

[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 3

[d] Percentage estimated in respect to sub total number of New England Faculty or Educators of Prospective Teachers contacted per state

[e] Percentage estimated in respect to total number of New England 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 New England Faculty (*N* = 992) or Educators of Prospective Teachers (*N* = 506) contacted to participate in the survey

**Table 2** Profile of the New England Faculty, Educators of Prospective Teachers, and College Students who participated in the study

Adapted from Paz-y-Miño-C G & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.

| | NE faculty | | Educators | | Students | | Grand Totals | |
|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Total | 244 | (21.5)[a] | 62 | (5.5)[a] | 827 | (73.0)[a] | 1,133 | (100)[a] |
| Females | 90 | (36.9)[b] | 37 | (59.7)[b] | 509 | (61.5)[b] | 636 | (56.1)[a] |
| Males | 154 | (63.1)[b] | 25 | (40.3)[b] | 318 | (38.5)[b] | 497 | (43.9)[a] |
| PhD degree | 220 | (90.2)[b] | 49 | (79.0)[b] | NA | NA | 269 | (23.7)[a] |
| Doctorate degree | 7 | (2.9)[b] | 5 | (8.1)[b] | NA | NA | 12 | (1.1)[a] |
| Masters degree | 17 | (6.9)[b] | 6 | (9.7)[b] | NA | NA | 23 | (2.0)[a] |
| Bachelors degree | NA | NA | 2 | (3.2)[b] | NA | NA | 2 | (0.2)[a] |
| Freshman | NA | NA | NA | NA | 213 | (25.8)[b] | 213 | (18.8)[a] |
| Sophomore | NA | NA | NA | NA | 192 | (23.2)[b] | 192 | (16.9)[a] |
| Junior | NA | NA | NA | NA | 182 | (22.0)[b] | 182 | (16.1)[a] |
| Senior | NA | NA | NA | NA | 240 | (29.0)[b] | 240 | (21.2)[a] |
| New England | 104 | (42.6)[bc] | 25 | (40.3)[bc] | 630 | (76.2)[bc] | 759 | (67.0)[a] |
| East Coast | 43 | (17.6)[bd] | 15 | (24.2)[bd] | 124 | (15.0)[bd] | 182 | (16.1)[a] |
| Other states | 67 | (27.5)[be] | 21 | (33.9)[be] | 50 | (6.0)[be] | 138 | (12.2)[a] |
| 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 New England Faculty ($N$ = 992) plus Educators of Prospective Teachers ($N$ = 506) and College 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 3 and 4

[b] Percentages in respect to total number of participants per group of New England 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 3 for statistical details concerning students and their institutions)

[c] New England: New England 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 College 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: New England 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 College Students natives corresponded to NY 7.3%, NJ 3.8%, PA 1.7%, MD 1.2%, DE and VA 1.0%

[e] Other states: New England 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 College 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: New England 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 College 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%

## Table 3 Institutions where the New England Faculty and Educators of Prospective Teachers were sampled

Adapted from Paz-y-Miño-C G & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.

| State / Institution (type)[a] | New England Faculty[b] | | | | | | | Educators of Prospective Teachers[c] | | | | | | |
| | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connecticut (CT)** | | | | | | | | | | | | | | |
| University of Connecticut (Pub) | 67 | 28 | 39 | NA | NA | NA | NA | 75 | 32 | 43 | NA | NA | NA | NA |
| University of Hartford (Pub) | 14 | 5 | 9 | NA | NA | NA | NA | 8 | 4 | 4 | NA | NA | NA | NA |
| Yale University (Priv) | 18 | 11 | 7 | NA | NA | NA | NA | 2 | 1 | 1 | NA | NA | NA | NA |
| Quinnipiac University (Priv) | 30 | 14 | 16 | NA | NA | NA | NA | 10 | 6 | 4 | NA | NA | NA | NA |
| Fairfield University (Rel Catholic) | 24 | 13 | 11 | NA | NA | NA | NA | 9 | 8 | 1 | NA | NA | NA | NA |
| Albertus Magnus College (Rel Catholic) | 6 | 2 | 4 | NA | NA | NA | NA | 3 | 1 | 2 | NA | NA | NA | NA |
| Sub Total   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] |
| **Maine (ME)** | | | | | | | | | | | | | | |
| University of Southern Maine (Pub) | 34 | 13 | 21 | NA | NA | NA | NA | 24 | 11 | 13 | NA | NA | NA | NA |
| University of Maine Orono (Pub) | 60 | 29 | 31 | NA | NA | NA | NA | 20 | 11 | 9 | NA | NA | NA | NA |
| University of New England (Priv) | 24 | 10 | 14 | NA | NA | NA | NA | 7 | 3 | 4 | NA | NA | NA | NA |
| Husson University (Priv) | 16 | 8 | 8 | NA | NA | NA | NA | 10 | 9 | 1 | NA | NA | NA | NA |
| St. Joseph's College of Maine (Rel Catholic) | 8 | 5 | 3 | NA | NA | NA | NA | 3 | 3 | 0 | NA | NA | NA | NA |
| Sub Total   ME | 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] |
| **Massachusetts (MA)** | | | | | | | | | | | | | | |
| University of Massachusetts Boston (Pub) | 50 | 17 | 33 | NA | NA | NA | NA | 24 | 14 | 10 | NA | NA | NA | NA |
| Fitchburg State College (Pub) | 26 | 11 | 15 | NA | NA | NA | NA | 10 | 8 | 2 | NA | NA | NA | NA |
| Springfield College (Priv) | 18 | 10 | 8 | NA | NA | NA | NA | 7 | 4 | 3 | NA | NA | NA | NA |
| Wheaton College (Priv) | 18 | 8 | 10 | NA | NA | NA | NA | 4 | 3 | 1 | NA | NA | NA | NA |
| Merrimack College (Rel Catholic) | 14 | 7 | 7 | NA | NA | NA | NA | 4 | 3 | 1 | NA | NA | NA | NA |
| Stonehill College (Rel Catholic | 18 | 9 | 9 | NA | NA | NA | NA | 5 | 3 | 2 | NA | NA | NA | NA |
| Sub Total   MA | 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] |
| **New Hampshire (NH)** | | | | | | | | | | | | | | |
| University of New Hampshire Durham (Pub) | 78 | 30 | 48 | NA | NA | NA | NA | 27 | 17 | 10 | NA | NA | NA | NA |
| Plymouth State University (Pub) | 28 | 15 | 13 | NA | NA | NA | NA | 15 | 11 | 4 | NA | NA | NA | NA |
| Dartmouth College (Priv) | 59 | 22 | 37 | NA | NA | NA | NA | 4 | 3 | 1 | NA | NA | NA | NA |
| Colby-Sawyer College (Priv) | 20 | 10 | 10 | NA | NA | NA | NA | 4 | 4 | 0 | NA | NA | NA | NA |
| Rivier College (Rel Catholic) | 8 | 5 | 3 | NA | NA | NA | NA | 10 | 8 | 2 | NA | NA | NA | NA |
| St. Anselm College (Rel Catholic) | 22 | 7 | 15 | NA | NA | NA | NA | 1 | 1 | 0 | NA | NA | NA | NA |
| Sub Total   NH | 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] |
| **Rhode Island (RI)** | | | | | | | | | | | | | | |
| University of Rhode Island (Pub) | 32 | 15 | 17 | NA | NA | NA | NA | 20 | 13 | 7 | NA | NA | NA | NA |
| Rhode Island College (Pub) | 32 | 16 | 16 | NA | NA | NA | NA | 82 | 52 | 30 | NA | NA | NA | NA |
| Brown University (Priv) | 46 | 19 | 27 | NA | NA | NA | NA | 17 | 9 | 8 | NA | NA | NA | NA |
| Roger Williams University (Priv) | 30 | 12 | 18 | NA | NA | NA | NA | 11 | 8 | 3 | NA | NA | NA | NA |
| Salve Regina University (Rel Catholic) | 10 | 6 | 4 | NA | NA | NA | NA | 10 | 9 | 1 | NA | NA | NA | NA |
| Providence College (Rel Catholic) | 28 | 9 | 19 | NA | NA | NA | NA | 13 | 10 | 3 | NA | NA | NA | NA |
| Sub Total   RI | 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] |

| Vermont (VT) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| University of Vermont Burlington (Pub) | 50 | 22 | 28 | NA | NA | NA | NA | 41 | 26 | 15 | NA | NA | NA | NA |
| Castleton State College (Pub) | 20 | 9 | 11 | NA | NA | NA | NA | 7 | 4 | 3 | NA | NA | NA | NA |
| Middlebury College (Priv) | 28 | 15 | 13 | NA | NA | NA | NA | 4 | 2 | 2 | NA | NA | NA | NA |
| Norwich University (Priv) | 26 | 16 | 10 | NA | NA | NA | NA | 1 | 1 | 0 | NA | NA | NA | NA |
| Saint Michael's College (Rel Catholic) | 20 | 8 | 12 | NA | NA | NA | NA | 9 | 6 | 3 | NA | NA | NA | NA |
| Green Mountain College (Rel Methodist) | 10 | 4 | 6 | NA | NA | NA | NA | 5 | 3 | 2 | NA | NA | NA | NA |
| Sub Total   VT | 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] |
| Unidentified state | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7 | NA | NA | 11.3[e] |
| Grand Totals | 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] | |

[a] Type of institution refers to public secular (Pub), private secular (Priv) and religious (Rel)

[b] New England 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, as follows: CT University of Connecticut ($N$ = 9): Anthropology, Communication Sciences, English, History, Human Development and Family Studies, Linguistics, Philosophy, Political Science, Psychology; University of Hartford ($N$ = 6): Art History, Communications, Computer Science, Legal Studies, Politics and Government, Sociology; Yale University ($N$ = 3): Astronomy, Forestry and Environmental Studies, History; Quinnipiac University ($N$ = 4): Business, Computer Science and Interactive Digital Design, Journalism, Public Relations; Fairfield University ($N$ = 4): Education, Philosophy, Political Science, Religious Studies; and Albertus Magnus College ($N$ = 2): Mathematics, Psychology. ME University of Southern Maine ($N$ = 6): Chemistry, Environmental Science, Engineering, History, Mathematics and Statistics, Philosophy; University of Maine-Orono ($N$ = 7): Anthropology, Art, Engineering, International Affairs, Mathematics and Statistics, Nursing, Political Science; University of New England ($N$ = 5): Business and Communications, English and Language Studies, Global Humanities, Psychology, Women's and Gender Studies; Husson University ($N$ = 3): Business, Education, Legal Studies; and Saint Joseph's College of Maine ($N$ = 4): Elementary Education, Criminal Justice, Exercise Science, Theology. MA University of Massachusetts Boston ($N$ = 7): Applied Linguistics, English, History, Mathematics, Political Science, Nursing and Health Sciences, Sociology; Fitchburg State College ($N$ = 4): Economics, History, Industrial Technology, Mathematics; Springfield College ($N$ = 4): Education, Mathematics/Physics and Computer Science, Social Work, Visual and Performing Arts; Wheaton College ($N$ = 3): Economics, English, Music; Merrimack College ($N$ = 3): Electrical Engineering, Sociology, Religious and Theological Studies; and Stonehill College ($N$ = 4): Business Administration, Economics, Mathematics, Religious Studies. NH University of New Hampshire-Durham ($N$ = 7): Anthropology, Art and Art History, Education, English, Health Management and Policy, History, Mathematics and Statistics; Plymouth State University ($N$ = 6): Business, Criminal Justice, Economics, Education, Mathematics, Philosophy; Dartmouth College ($N$ = 9): Anthropology, Computer Science, Economics, Engineering Science, English, Geography, Mathematics, Physics and Astronomy, Women's and Gender Studies; Colby-Sawyer College ($N$ = 4): Business Administration, Education, Psychology, Social Science; Rivier College ($N$ = 3): Business Administration, Nursing, Psychology; and St. Anselm College ($N$ = 3): English, History, Humanities. RI University of Rhode Island ($N$ = 4): Chemistry, English, Nursing, Journalism; Rhode Island College ($N$ = 6): Art, Communications, English, History, Philosophy, Physical Sciences; Brown University ($N$ = 8): Anthropology, Education, History, Philosophy, Political Sciences, Psychology, Sociology, Visual Arts; Roger Williams University ($N$ = 11): Architecture, Chemistry, Communications, Computer Sciences, Creative Writing, Dance, English, History, Political Sciences, Psychology, Theater; Salve Regina University ($N$ = 3): Anthropology, Business Studies, Religious and Theological Studies; and Providence College ($N$ = 8): Art History, English, History, Philosophy, Political Science, Psychology, Secondary Education, Sociology. VT University of Vermont- Burlington ($N$ = 9): Anthropology, Biochemistry, Education, Engineering, English, Geology, Mathematics and Statistics, Molecular Physiology and Biophysics, Physics; Castleton State College ($N$ = 4): Business Administration, Sociology/Social Work and Criminal Justice, Music, Natural Sciences; Middlebury College ($N$ = 4): Economics, Education Studies, Geography, Religion; Norwich University ($N$ = 6): Chemistry and Biochemistry, Geology and Environmental Science, Mathematics, Nursing, Physics, Sports Medicine; Saint Michael's College ($N$ = 5): Computer Science, Economics, History, Political Science, Sociology and Anthropology; Green Mountain College ($N$ = 3): Environmental Studies, Communications and Journalism, History

[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, as follows: CT University of Connecticut ($N$ = 7): Comprehensive Special Education, Curriculum and Instruction, Educational Leadership, Educational Psychology, Mathematics Education, Music Education, and Teachers Education; University of Hartford ($N$ = 6): Education and Human Services, Early Childhood Education, Educational Technology, Elementary Education, Integrated Elementary and Special Education, and Secondary Education-English; Yale University ($N$ = 1): Teacher Preparation and Education Studies; Quinnipiac University ($N$ = 4): Elementary Education, Secondary Education, Educational Leadership, and Teacher Leadership; Fairfield University ($N$ = 5): Curriculum and Instruction, Elementary Education, Secondary Education, Special Education, and Teachers of English to Speakers of Other Languages Program; and Albertus Magnus College ($N$ = 2): Elementary Education and Secondary Education. ME University of Southern Maine ($N$ = 3): Human Resource Development, Professional Education, and Teacher Education; University of Maine-Orono ($N$ = 6): Athletic Training, Child Development and Family Relations, Early Childhood Education, Elementary Education, Kinesiology and Physical Education, and Secondary Education; University of New England ($N$ = 2): Elementary Education and Secondary Education; Husson University ($N$ = 6): Counseling Education, Elementary Education, Experiential Learning, Health Education, Physical Education, and Secondary Education; and Saint Joseph's College of Maine ($N$ = 3): Adult Education and Training, Health Care Education, and School Education and Leadership. MA University of Massachusetts Boston ($N$ = 4): Counseling and School Psychology, Curriculum and Instruction, Early Education and Care in Inclusive Settings, and Educational Leadership; Fitchburg State College ($N$ = 4): Early Childhood Education, Educational Leadership and Management, Elementary Education, and Middle School Education; Springfield College ($N$ = 5): Early Childhood, Educational Studies, Elementary, Elementary and Special Education Dual Licensure, and Secondary; Wheaton College ($N$ = 3): Early Childhood and Elementary Education, General Education, and Secondary Education; Merrimack College ($N$ = 4): Early Childhood Education, Elementary Education, Human Development, and Secondary Education and Foreign Languages; and Stonehill College ($N$ = 3): Early Childhood Education, Elementary Education, and Secondary Education. NH University of New Hampshire-Durham ($N$ = 7): Administration and Supervision, Counseling, Early Childhood, Environmental Education, Reading, Special Education, and Teacher Education; Plymouth State University ($N$ = 4): Childhood Studies, Early Childhood Studies, Educational Leadership, and Elementary Education; Dartmouth College ($N$ = 1): Teacher Education; Colby-Sawyer College

(N = 3): Child Development, Early Childhood Education, and Social Sciences and Education; Rivier College (N = 5): Early Childhood Education, Educational Administration, Elementary Education, Secondary Education, and Special Education; and St. Anselm College (N = 3): Elementary Education, Middle/Secondary Certification, and Teaching English Speakers of Other Languages. RI University of Rhode Island (N = 6): Early Childhood Education, Elementary Education, Music Education, Physical Education, Secondary Education, and Special Education; Rhode Island College (N = 15): Advance Studies in Teaching and Learning, Counseling, Early Childhood Education, Education Leadership, Educational Studies, Elementary Education, Health Education, Middle-level Endorsement, Physical Education, Reading, Secondary Education, School Psychology, Special Education, Teaching English as a Second Language, and Technology Education; Brown University (N = 5): Elementary Education, Integrated Elementary Education, Secondary Education, Undergraduate Teachers, and Urban Education Policy; Roger Williams University (N = 3): Elementary Education, Literacy Education, and Secondary Education; Salve Regina University (N = 5): Early Childhood Education, Elementary Education, Music Education, Secondary Education, and Special Education; and Providence College (N = 5): Administration, Counseling, Elementary/Special Education, Literacy, and Secondary Education. VT University of Vermont- Burlington (N = 9): Art Education, Curriculum and Instruction, Early Childhood, Elementary Education, Middle-level Education, Music, Physical Education, Reading and Language Arts, and Special Education; Castleton State College (N = 5): Curriculum and Instruction, Elementary Education, Language-Arts and Reading, Secondary Education, and Special Education; Middlebury College (N = 1): Education Studies; Norwich University (N = 2): Elementary Education and Secondary Education; Saint Michael's College (N = 8): Arts Education, Curriculum, Elementary Education, English as a Second Language, Reading, School Leadership, Secondary Education, and Special Education; and Green Mountain College (N = 6): Adventure Education, Art Education, Elementary Education, English Secondary Education, History Secondary Education, and Special Education

[d] Percentage estimated in respect to sub total number of New England Faculty or Educators of Prospective Teachers contacted per state

[e] Percentage estimated in respect to total number of New England 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 New England Faculty (N = 992) or Educators of Prospective Teachers (N = 506) contacted to participate in the survey

# Table 4 Detailed profiles of the College Students and their institutions sampled in the study

Adapted from Paz-y-Miño-C G & Espinosa A. 2012b. Educators Of Prospective Teachers Hesitate To Embrace Evolution Due To Deficient Understanding Of Science/Evolution And High Religiosity. *Evolution: Education & Outreach* 5: 139–162, with permission.

| | Public Secular | | | | Private Secular | | | | Religious I | | | | Religious II | | | | Grand Totals | |
| | Contacted | | Responders | | Contacted | | Responders | | Contacted | | Responders | | Contacted | | Responders | | Responders | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 7,982 | (100)[a] | 161 | (2.0)[a] | 3,806 | (100)[a] | 298 | (7.8)[a] | 3,910 | (100)[a] | 185 | (4.7)[a] | 1,923 | (100)[a] | 183 | (9.5)[a] | 827 | (100)[b] |
| Females | 3,792 | (47.5)[a] | 95 | (59.0)[c] | 1,899 | (49.9)[a] | 185 | (62.1)[c] | 2,172 | (55.5)[a] | 111 | (60.0)[c] | 1,328 | (69.1)[a] | 118 | (64.5)[c] | 509 | (61.5)[b] |
| Males | 4,191 | (52.5)[a] | 66 | (41.0)[c] | 1,907 | (50.1)[a] | 113 | (37.9)[c] | 1,738 | (44.5)[a] | 74 | (40.0)[c] | 595 | (30.9)[a] | 65 | (35.5)[c] | 318 | (38.5)[b] |
| Freshman | 2,786 | (34.9)[a] | 49 | (30.4)[c] | 1,179 | (31.0)[a] | 79 | (26.5)[c] | 970 | (24.8)[a] | 44 | (23.8)[c] | 592 | (30.8)[a] | 41 | (22.4)[c] | 213 | (25.8)[b] |
| Sophomore | 1,796 | (22.5)[a] | 46 | (28.6)[c] | 947 | (24.9)[a] | 67 | (22.5)[c] | 970 | (24.8)[a] | 42 | (22.7)[c] | 419 | (21.8)[a] | 37 | (20.2)[c] | 192 | (23.2)[b] |
| Junior | 1,828 | (22.9)[a] | 28 | (17.4)[c] | 905 | (23.8)[a] | 70 | (23.5)[c] | 997 | (25.5)[a] | 50 | (27.0)[c] | 398 | (20.7)[a] | 35 | (19.1)[c] | 182 | (22.0)[b] |
| Senior | 1,572 | (19.7)[a] | 38 | (23.6)[c] | 775 | (20.4) | 82 | (27.5)[c] | 973 | (24.9)[a] | 49 | (26.5)[c] | 514 | (26.7)[a] | 70 | (38.3)[c] | 240 | (29.0)[b] |
| New England | 7,846 | (98.3)[ad] | 145 | (90.1)[ce] | 2,864 | (75.2)[ad] | 222 | (74.5)[ce] | 2,615 | (66.9)[ad] | 124 | (67.0)[ce] | 1,552 | (80.7)[ad] | 139 | (76.0)[ce] | 630 | (76.2)[b] |
| East Coast | 56 | (0.7)[af] | 6 | (3.7)[cg] | 700 | (18.4)[af] | 58 | (19.5)[cg] | 976 | (24.9)[af] | 38 | (20.5)[cg] | 274 | (14.2)[af] | 22 | (12.0)[cg] | 124 | (15.0)[b] |
| Other | 48 | (0.6)[ah] | 5 | (3.1)[ci] | 141 | (3.7)[ah] | 10 | (3.4)[ci] | 283 | (7.2)[ah] | 16 | (8.7)[ci] | 75 | (3.9)[ah] | 19 | (10.4)[ci] | 50 | (6.0)[b] |
| Foreign countries | 32 | (0.4)[aj] | 5 | (3.1)[ck] | 101 | (2.7)[aj] | 8 | (2.7)[ck] | 36 | (1.0)[aj] | 7 | (3.8)[ck] | 22 | (1.2)[aj] | 3 | (1.6)[ck] | 23 | (2.8)[b] |

[a] Percentages in respect to total number of students contacted per institution (Public Secular = University of Massachusetts Dartmouth *N* = 7,982; Private Secular = Roger Williams University *N* = 3,806; Religious I = Providence College *N* = 3,910; and Religious II = Salve Regina University *N* = 1,923). Note that 17,621 students were contacted of which a grand total of 827 (4.7%) responded to the survey

[b] Percentages in respect to grand total number of responders *N* = 827

[c] Percentages in respect to total number of responders to the survey per institution (Public Secular = 161, Private Secular = 298, Religious I = 185, Religious II = 183)

[d] New England contacted: Public Secular institution were natives from MA 95.3%, RI 1.9%, CT, NH, ME and VT 1.1%; Private Secular institution were natives from MA 35.8%, CT 20.4%, RI 11.3%, NH 4.4%, ME 2.1%, and VT 1.2%; Religious I institution were natives from MA 34.2%, CT 15.4%, RI 13.1%, NH 2.5%, ME and VT 1.7%; and Religious II institution were natives from MA 27.9%, RI 26.8%, CT 19.6%, NH 3.1%, ME 2.5%, and VT 0.8%

[e] New England responders: Public Secular institution were natives from MA 86.6%, RI 2.5%, and CT 1.0%; Private Secular institution were natives from MA 29.1%, CT 19.3%, RI 15.4%, NH 6.5%, VT 2.8, and ME 1.4%; Religious I institution were natives from MA 37.2%, RI 14.1%, CT 11.2%, NH 2.0%, ME 1.5%, and VT 1%; and Religious II institution were natives from MA 26.4%, RI 24.8%, CT 18.8%, NH 2.9%, ME 1.8, and VT 1.3%

[f] East Coast contacted: Public Secular institution were natives from NY, NJ, VA, MD and DE 0.7%; Private Secular institution were natives from NY 9.9%, NJ 6.7%, PA, MD, DC and VA 1.8%; Religious I institution were natives from NY 15.7%, NJ 6.4%, PA 1.5%, MD, VA, DE and DC 1.3%; and Religious II institution were natives from NY 7.4%, NJ 5.3%, PA, FL, MD, VA, DC and SC 1.5%

[g] East Coast responders: Public Secular institution were natives from NY 2.7%, NJ and VA 1.0%; Private Secular institution were natives from NY 9.8%, NJ 5.2%, PA 2.3%, MD 1.2%, and VA 1.0%; Religious I institution were natives from NY 10.2%, NJ 6.8%, PA 2.5%, DE and VA 1.0%; and Religious II institution were natives from NY 7.0%, NJ 3.2%, MD 1.0%, PA and VA 0.8%

[h] Other contacted: Public Secular institution were natives from thirteen states and sixteen unidentified states  0.6%; Private Secular institution were natives from twenty states  3.7%; Religious I institution were natives from to twenty eight states  7.2%; and Religious II institution were natives from to seventeen states  3.9%

[i] Other responders: Public Secular institution were natives from four states AZ, FL, MI, and TX  3.1%; Private Secular institution were natives from nine states CA, CO, GA, IL, IN, KT, MI, TN, and WA  3.4%; Religious  I institution were natives from eleven states CA, FL, IL, IN, MN, MO, OH, OR, SC, TN, and TX  8.7%; and Religious  II institution were natives from eleven states CA, FL, HI, IN, MI, MO, NM, OH, TN, TX, WI, plus Puerto Rico and four unidentified states  10.4%

[j] Foreign countries contacted: Public Secular institution corresponded to sixteen nationalities  0.4%; Private Secular institution corresponded to forty two nationalities 2.7%; Religious I institution corresponded to fourteen nationalities 1.0%; and Religious II institution corresponded to eight nationalities 1.2%

[k] Foreign countries responders: Public Secular institution corresponded to four nationalities (Brazil, Cape Verde, Cameroon, and Philippines  3.1%); Private Secular institution corresponded to eight nationalities (France, Ghana, India, Korea, Lebanon, Peru, Romania, and UK  2.7%); Religious I institution corresponded to seven nationalities (Bosnia, Canada, Ghana, Korea, Latvia, Portugal, and Zimbabwe  3.8%); and Religious II institution corresponded to three nationalities (Ecuador, Japan, and Rwanda 1.6%)

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