

Creatures in the Classroom: Preservice Teacher Beliefs About Fantastic Beasts, Magic, Extraterrestrials, Evolution and Creationism

Susan Carol Losh · Brandon Nzekwe

Published online: 11 June 2010
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Abstract Faculty have long expressed concern about pseudoscience belief among students. Most US research on such beliefs examines evolution-creation issues among liberal arts students, the general public, and occasionally science educators. Because of their future influence on youth, we examined basic science knowledge and several pseudoscience beliefs among 540 female and 123 male upperclass preservice teachers, comparing them with representative samples of comparably educated American adults. Future teachers resembled national adults on basic science knowledge. Their scores on evolution; creationism; intelligent design; fantastic beasts; magic; and extraterrestrials indices depended on the topic. Exempting science education, preservice teachers rejected evolution, accepting Biblical creation and intelligent design accounts. Sizable minorities “awaited more evidence” about fantastic beasts, magic, or extraterrestrials. Although gender, disciplinary major, grade point average, science knowledge, and two religiosity measures related to beliefs about evolution-creation, these factors were generally unassociated with the other indices. The findings suggest more training is needed for preservice educators in the critical evaluation of material evidence. We also discuss the judicious use of pseudoscience beliefs in such training.

1 Introduction

To the dismay of many scientists, scholars and faculty, pseudoscience beliefs are popular in American society, including among college students. We define such beliefs as “cognitions about material phenomena that claim to be ‘science,’ yet use non-scientific evidentiary processes [e.g.,] authoritative assertion ...anecdote...or unelaborated ‘natural’ causes” (Losh et al. 2003). It is important to understand pseudoscience beliefs, partly because they provide one way to study which information people find compelling enough

S. C. Losh (✉) · B. Nzekwe
Department of Educational Psychology and Learning Systems, Florida State University,
Tallahassee, FL 32306-4453, USA
e-mail: slosh@fsu.edu

B. Nzekwe
e-mail: nzekwebrandon@hotmail.com

to support such assertions, partly because their practitioners regularly present claims on public expenditures or political support, and partly because private citizens contact and elect public officials, thereby influencing policy and funding.

Most research on pseudoscience beliefs addresses creation/evolution among liberal arts undergraduates (Martin 1994; Goode 2002; Harrold and Eve 1987), general public adults (National Science Board 2008; Miller and Kimmel 1998), or, occasionally, educators (Clément and Quessada 2008, 2009; Eve and Dunn 1990; Feder 1984). However, this focus is overly restrictive: first, emphases on evolution-”creationism”, while vital, are too narrow. “Alternative medicine” can kill; costly psychics encourage fatalism; in short, all kinds of pseudoscience belief ill equip individuals to make informed judgments about science and technology or about social policy.

Second, almost no systematic research addresses these beliefs among preservice teachers *in different disciplines*. Many—in some states *most*—elementary educators teach science, creating the scaffold to influence how students later construct science knowledge. How these teachers do so may affect the “turn off” that scholars note often occurs among middle school students (National Science Board 2008).

Each instructor influences hundreds, often thousands, of students. Furthermore, the general public believes educators contribute to society more than most professionals (Pew Forum on Religion and Public Life 2009).¹ Thus, *this study examines diverse pseudoscience beliefs among preservice teachers, in part comparing them with the undergraduate-educated general public.*

1.1 Pseudoscience Overall Prevalence

Perhaps pseudoscience belief prevalence is to be expected: media bombard Americans with horoscopes, science fiction, miracle cures, and invitations to “creation science” museums. Well-publicized battles have arisen over science education, applications (e.g., global warming), and “intelligent design” or “ID” (Binder 2007; Holden 1987; Jones 2007; Mellor 2003; Pennock 2002; Skoog 1984; Trefil 2008).

Its sheer extent is daunting. Journalist Christine Wicker (2003, 2005) has tracked mediums, psychics, hoodoo practitioners and would-be vampires. She initially expressed surprise at the support she uncovered for spiritualism, magic, and new age rituals. Her impressions are sustained by national surveys of adults.

To provide a context for our new preservice teacher data, we reviewed national surveys of adult pseudoscience beliefs among the American general public, i.e., the parents, neighbors, counselors, clergy and other adults who not only socialize current pupils but also many future teachers. For example, the 2008 National Science Foundation (NSF) in-person interviews found that 5% rated astrology very scientific, 29% rated it “sort of” scientific and 4% did not know. 31% of 2008 General Social Survey (GSS) respondents accepted reincarnation (6% were unsure) and 24% said their deceased ancestors had “supernatural powers” (5% were unsure.)

About *two-thirds* of adults in the Pew (Pew Forum on Religion and Public Life 2009) landline and cellular Random Digit Dial (RDD) survey reported *at least one* of the following: personally communicating with the dead (29%), seeing or experiencing a ghost (18%), visiting a fortuneteller or psychic (15%), or endorsing reincarnation (24%),

¹ Besides the military (84%), teachers (77%) were the most highly rated in contributing “a lot to society’s well-being”, outranking “scientists” (Pew Forum on Religion and Public Life 2009) (70%), medical doctors (69%), and far surpassing lawyers (23%).

“spiritual energy” in physical entities, such as trees (26%), astrology (25%), or the “evil eye” (16%). In a separate survey for the American Association for the Advancement of Science (AAAS, Pew Forum on Religion and Public Life 2009),² Pew reported substantial disparities between scientists and the public, especially on evolution, which 87% of scientists but only 32% of the general public endorsed. Indeed, in recent decades, most US adults have supported teaching both *Biblical* creation and evolution in the schools (Plutzer and Berkman 2008).

Upon finding sizable acceptance of “creation science” and noteworthy minority support for contacting the dead or psychic powers (each 29%) among *biology teachers*, Eve and Dunn (1990, p. 19) wrote, “a significant proportion of high school life science and biology teachers hold many beliefs...at odds with mainstream science”. More recently, one-fourth of the high school biology educators Berkman et al. (2008) surveyed by mail or email reported teaching *Biblical* creation, although only half of those saw it as a valid alternative to evolution; 16% of these teachers identified as “Young Earth Creationists”. Yet studying future *elementary educators* or *secondary school teachers in other fields* is rare. Because educators are so vital in socializing youth, it is important to know about preservice teacher pseudoscience beliefs.

Eve or Feder’s research also illustrates the need to study diverse ersatz science topics. “Common sense” suggests that *Biblical* literalists would reject astrology as heresy, yet Wicker (2005) found extensive coexistence of Christianity with folk magic and Pew (Pew Forum on Religion and Public Life 2009) reported similar national survey findings. *Positive correlations* among diverse pseudoscience beliefs could imply shortcomings in critical thinking and evaluation of evidence about material phenomena that teacher educators can address. However, because pseudoscience belief research topics have been so restricted, we know relatively little about the nature of such possible interrelationships.

1.2 Cognitive and Emotional Correlates of Pseudoscience Belief

Why might individuals readily accept pseudoscience assertions? The *Project 2061 Benchmarks* for science literacy (AAAS 2009: chapter 12, revised) addresses “Habits of Mind” conducive to understanding science, including “[q]uantitative, communication, manual, and critical-response skills...essential for problem solving,” e.g., asking astute questions, evaluating relevant evidence, separating fact from opinion, manipulating objects and keeping good records. Hopefully, these skills assist individuals for a lifetime in evaluating health, political, commercial, and technological claims.

Qualities such as curiosity and skepticism are difficult to operationalize. Our primary, related conceptual perspective reflects the empirical tradition of heuristics (e.g., Kahneman et al. 1982), which describe cognitive mechanisms and shortcuts that people use to segment and compartmentalize or isolate information, overestimate rare events and transform coincidence into causal connections (Fiske and Taylor 1991; Pratkanis 1992; Taylor et al. 1995; Willingham 2007). For example, by isolating religious teachings from ghost-hunting anecdotes in different schema, someone can simultaneously endorse ghosts and the *Bible*. We especially draw upon this research literature in our conclusions.

Heuristics have been applied to pseudoscience beliefs (Goode 2002). Studying creationists or sci-fi fantasies can provide a frame to elaborate how people contemplate science, help identify the evidence, assertions, and persuasive styles that people find compelling, and describe causal mechanisms they believe operate in the material world.

² This RDD survey of 2001 adults occurred in April and May 2009; a later, related RDD survey in June 2009 surveyed another 1005 adults.

Constructs such as “priming,” “schema,” or “selectivity” describing the selection and interpretation of data are now ubiquitous in the cognitive and education literature. Pseudoscience emphasizes on definitive “proof,” vividness, and experiential anecdotes, comparable to presentation styles used in headlines, authoritative sound bites and pastoral sermons may be more convincing than science statements about disproof or alternative hypotheses. As a way of constructing causal explanations science assertions can appear hesitant and inconclusive to untrained individuals (Losh 2003; Pratkanis 1995; Stanovich 2001; Stempien and Coleman 1985).

More emotional and ideological reasons center on fear and distrust. Specter (2009) sees distrust of “greedy” “establishment science” and “Big Pharma” as motivating opposition to vaccination or genetically engineered foods. Wicker (2003, 2005) identified fear of the future or the unknown as encouraging “fantastic” beliefs. Other motives she found include the hope magical practitioners extend, concrete rituals involved with hoodoo, and the “failure” of conventional religion and science to address matters of life and meaning for these pseudoscience adherents.

1.3 Educational and Religious Determinants

When we initially examined pseudoscience belief, like other scholars, we suspected that poorly educated individuals, stymied by new technologies and discoveries, cling to traditional explanations (e.g., *Biblical* creation) of material phenomena. Through providing more intellectually sophisticated knowledge and skillful evaluation of information, education is considered one inoculation against pseudoscience belief. However, the situation is more complex: first, adult educational level is an ambiguous variable, confounded with age, generation (recent cohorts have higher levels), and gender (women and men enter different disciplines). More educated adults have completed more science courses. The less educated more often subscribe to inerrant religious doctrines.

As forms of pseudoscience differ, so do determinants. “Traditional pseudoscience”, so-called because *Biblical* creation, astrology, or seers have existed for centuries, declines with formal education (Goode 2002; Losh et al. 2003). Endorsing alternative medicine, extraterrestrial visits, “new age” or science fiction fantasies, often does not. New Age devotees can be well educated (Taylor et al. 1995; Goode 2002).

Specter (2009) illustrated his chapter on opposition to childhood vaccines³ with a wealthy well-educated suburb. The Pew Forum on Religion and Public Life (2009) found baccalaureate adults more often eschewed required vaccinations for their children (32%) than the high school educated (24%). In the later Pew survey (2009), 17% of the better educated admitted consulting psychics compared with 13% of the high school educated. Although communicating with the dead or experiencing a ghostly presence was lower among the college educated, percentage differences were small.

Consider the notable technological and science achievements in the Victorian era: pseudosciences such as clairvoyance or misinterpretations such as Social Darwinism and eugenics also flourished among the better-educated British and American upper and middle classes. Juxtaposed against the seeming miracles of the trans Atlantic telegraph or airplanes, Victorian pseudoscience, e.g., séances to “contact the dead”, seem less farfetched.

³ The most publicized opposition to childhood vaccines addresses a proposed link between them and autism, which has been so repeatedly discredited by well-publicized published analyses over the past several years that *Lancet* retracted its original 1998 article in early 2010 and all but one author previously disavowed it. The evidence now used to support such a link is anecdotal or “intuitive” and lacks scientific verification, although as the Pew study illustrates such a link may still resonate with a sizable minority of Americans.

Given a steady stream of technical marvels, the line between science and fiction in the educated public can begin to blur, and pseudoscience beliefs can grow.

Religions that stress inerrant liturgical obedience are cited as another source of pseudoscience support; beliefs about *Biblical* creation can be embedded in religious cognitive schema. General public evangelical Christians do reject evolution more often and endorse *Biblical* creation (Pew Forum on Religion and Public Life 2009). Darwinian theory threatens the theological positions of a “young Earth” or humanity directly created in God’s image. Some scholars (e.g., Good 2005) propose that authoritarian religious doctrine also can dampen the intellectual curiosity and open-mindedness that encourage students to bring skeptical thinking to bear on explaining material phenomena.

In the AAAS Pew survey 52% of White Christian Evangelicals agreed, science conflicted with their religious beliefs, more than Catholics (44%), Black Protestants (34%), White “mainline” Protestants (30%) or the unaffiliated (16%). Only 9% of White Evangelicals chose “natural” evolution, compared with 60% of the unaffiliated, 38% of White mainline Protestants, 33% of Catholics, and 17% of Black Protestants.

Wicker (2003, 2005) found mediums or hoodoo practitioners could comfortably subscribe to many Christian beliefs. The (2009) Pew survey reported Catholics, White mainline Protestants and Black Protestants accepted reincarnation, astrology and “spiritual energy” more than White Protestant Evangelicals and more often reported contacting the dead, experiencing ghosts or consulting psychics. Black Protestants or Catholics believed in the “evil eye” more than White Evangelicals. White Evangelicals with higher service attendance more often rejected such pseudoscience beliefs or experiences. It almost appears, apart from *Biblical* creationism, that evangelical Christianity to some degree inoculates against many pseudoscience topics. At any rate, how religion affects pseudoscience belief is far from uniformly straightforward.

1.4 Research Questions

- Given US society’s strong regard for educators yet penchant for pseudoscience beliefs, how do preservice teachers compare to comparably educated American adults in basic science knowledge and pseudoscience belief?
- How do gender, general science knowledge (net of evolution), education major, religious variables and other factors relate to *different types* of pseudoscience belief among preservice teachers?⁴
- How do different types of pseudoscience belief relate to each other among preservice educators?

2 Methods

2.1 Preservice Educator Participants

Preservice educators were 540 female and 123 male upper classmen in 2007 (median age 20) enrolled in required education courses at a large, Southeastern state university. They majored in elementary education (49%), social studies (16%), English (13%), math (9%),

⁴ Following Rosenberg (1968) or Schneider et al. (2007), we assign causal precedence in observational data multivariate analysis to variables occurring earlier in time (e.g., gender; elementary school science knowledge), or of wide cognitive or affective coverage (e.g., self-rated religious importance, see below).

physical education (7%) and science education (3.5%). 90% were White, 8% Black, and 2% were Asian; 8% identified as Hispanic. A unique identifier eliminated duplicate surveys. Program coordinators or the College Dean confirmed major enrollments.

Most women were elementary education majors; only 8% were future math educators and 3% were science education majors. Only 9% of men majored in elementary education versus 35% in social studies education, 16% in math education, but only 5% in science education. 83% of education students were taught evolution in high school—although 40% of that number also was taught “creationism”.

2.2 Preservice Educator Instruments

Preservice teachers completed a *survey* including demographics and 88 knowledge and belief items comparable to prior research (Eve and Dunn 1990; Feder 1984). 11 knowledge items came from the NSF Surveys of Public Understanding of Science and Technology including 10 “Oxford items” (Allum et al. 2008) addressing science facts taught in late elementary school and reviewed in middle school. In this study an evolution item typically used as an “Oxford item” became part of the Evolution index. An 11th item addressed coin toss probabilities. Prior research (Losh et al. 2003) indicates inconsistent relationships between science knowledge and pseudoscience belief, which we also examine later in our analyses.

Other composite measures were: support for (a) evolution; (b) *Biblical* creation; (c) intelligent design; (d) fantastic creatures, e.g., “Bigfoot”; (e) magic, psychics or astrology; and (f) extraterrestrial aliens. We wanted to distinguish literal “creationism” from the more recent “ID” or “naturalistic” evolution⁵ and also to address other “traditional” (magic) and “modern” (extraterrestrials) pseudoscience topics. We scored the percent correct for the Oxford items. Pseudoscience index construction is described below in more detail. Items used to build indices are presented in Table 1.

We used two religiosity indicators: (1) general denomination: “Mainline” (50%); Fundamentalist (23%, e.g., Southern Baptist Convention); Charismatic (10%, e.g., Assembly of God); or None (17%) and (2) a self-rated 10-point personal religious importance item (median = 8; interquartile range = 5–10; 31% rated themselves “10” or very important). Two sources were used to create denomination: the student’s own self-characterization on a generic item when available (e.g., “agnostic” or “fundamentalist”) and prior sociological work describing denominations (e.g., Davis and Smith 2009).

2.3 National Probability Samples of Adults

Because there are so little data on pseudoscience belief (exempting creation-evolution) in representative US surveys, we reference several sources. Later we show results from adults with some college, an associate’s degree or a baccalaureate, i.e., similar education levels to preservice teachers, in five studies: (1) The RDD 2001 NSF Surveys ($n = 1574$; college subsample = 550); (2) NSF 2008 ($n = 1505$; subsample = 391), in-person interviews through the GSS (Davis and Smith 2009); (3) a *second separate* 2008 GSS module ($n = 1365$; subsample = 378); (4) two related 2009 Pew RDD polls, April/May ($n = 2001$; subsample = 1202) and June ($n = 1005$; subsample = 522); (5) 2003 RDD Pew surveys collected in August 2009 (2009; subsample = 1259).

⁵ In this study, with the exception of a single question, we cannot directly distinguish between “evolution” and “theistic evolution”, which typically accepts both an old earth and common descent but asserts that God initiated evolutionary processes. Future research should have more items addressing the differences.

Table 1 Questionnaire items for study indices^aEvolution ($r\text{-bar} = 0.27$ coefficient $\alpha = 0.65$)

The world is between 4 and 5 billion years old

The theory of evolution correctly explains the development of life on earth

Humanity came to be through evolution, which occurred WITHOUT the help of God

The theory of evolution should be taught in public schools as an explanation of origins

Human beings, as we know them today, developed from earlier species of animals

"Creationism" ($r\text{-bar} = 0.41$ coefficient $\alpha = 0.78$)

There is a good deal of scientific evidence against evolution and in favor of the Bible's account of creation (2)

Adam and Eve, the first human beings, were created by God

God created humanity pretty much in its present form within the last 10,000 years or so

The Bible's account of creation should be taught in public schools as an explanation of origins

"Intelligent Design" ($r\text{-bar} = .33$ coefficient $\alpha = 0.60$)

Humans are too complicated to have come to be through natural processes, their existence reflects the will of an intelligent designer

Evolution should not be the only theory of human origins taught in the public school systems

Humanity was created over a short period of time by an intelligent designer^b

Creatures (fantastic beasts; $r\text{-bar} = 0.27$ coefficient $\alpha = 0.43$)

The Loch Ness "Monster" exists only in the imagination

"Bigfoot" (Sasquatch) is a real creature roaming the woods in the American Northwest

Magic ($r\text{-bar} = 0.24$ coefficient $\alpha = 0.61$)

White or Black magic really exists

Some people can predict future events by psychic power

Astrology is an accurate predictor of future events

One cannot read other people's thoughts by psychic powers

Astrology is an accurate predictor of people's personalities

Extraterrestrials ($r\text{-bar} = 0.32$ coefficient $\alpha = 0.65$)

Aliens from other worlds are responsible for ancient monuments like the pyramids, which primitive people could not have built

UFOs are actual spacecraft from other planets

Aliens from other worlds visited earth in the past

Our government is hiding information about the fact that UFOs are alien spacecraft

The Oxford items (True or False Questions)

The earliest humans lived at the same time as the dinosaurs

The continents on which we live have been moving their location for millions of years and will continue to move in the future

Antibiotics kill viruses as well as bacteria

Electrons are smaller than atoms

Lasers work by focusing sound waves

It is the father's gene that decides whether the baby is a boy or a girl

The oxygen we breathe comes from plants

All radioactivity is man-made

The center of the Earth is very hot

Table 1 continued

How long does it take the Earth to go around the sun? (a) 1 day; (b) 1 month; (c) 1 year; (d) 10 years; (e) the Earth does not go around the sun

If a coin is tossed, the probability that it will land “heads up” is one half. In four successive tosses, a coin lands “heads up” each time. What is most likely to happen when the coin is tossed a fifth time? (a) it is likely to land “heads up”; (b) It is likely to land “tails up”; (c) It is equally likely to land “heads up” or “tails up”; (d) More information is needed to answer the question

^a These items took the following format: Please select the phrase after each statement that most clearly describes your belief about the statement: (a) Agree strongly; (b) Agree somewhat; (c) Disagree somewhat; (d) Disagree strongly; (e) Undecided; the available evidence is inconclusive; (f) Never heard of it/don't know enough to have an opinion

^b Some “Intelligent Design” proponents will accept an “old earth”; others will not. The key here was the phrase “intelligent designer”

Other than the NSF Surveys, where we deliberately drew items for preservice teacher-adult comparisons, it was hard to find *exact* question matches. We found items about reincarnation, the dead, astrology, UFOs, psychics, ghosts, and curses. However, some items reference *behaviors* (visiting psychics) not beliefs, and some are generic (the “evil eye”) versus specific (*King Tut's* curse). The distributions below illustrate several pseudoscience beliefs or experiences among US adults with some college or a BA, thus providing a context for pseudoscience prevalence among future teachers.

3 Results

3.1 Preservice Teachers and American Adults: Very Basic Science Knowledge

Preservice teachers averaged 78% correct on basic science facts, comparable to 74% in the (2009) Pew survey and 74% in the 2008 NSF Surveys among undergraduate-educated adults. 84% of 2008 NSF Surveys respondents correctly answered the applied probability question, compared with 81% of education majors.

3.2 National Adult Samples and Preservice Teachers on Pseudoscience

Selected results from national surveys of college educated adults and preservice teachers are shown in Table 2. Excepting creationism, minorities of college-educated US adults or our preservice educator sample endorsed fantastic beasts, alien landings or various forms of magic, astrology or psychics. Nonetheless, *nonnegligible* minorities endorsed psychics, reincarnation, ghosts, and communion with or supernatural powers of the dead (half of education majors *disagreed* “it is impossible to communicate with the dead”).

3.3 Pseudoscience Beliefs Among Preservice Teachers

Table 3 presents preservice teacher percentage distributions on the Evolution, Creation, Intelligent Design, Creatures, Magic, and Extraterrestrials index items. In constructing these indices, we counted the number of agree strongly or agree somewhat responses per index (means and standard deviations are in Table 3). Virtually all “other” responses were “the evidence is inconclusive”; we found the levels of uncertainty striking as these college juniors and seniors “awaited more evidence” on several topics.

Table 2 College educated general public adults and preservice educators on pseudoscience support

(GSS 2008) ^a Believe in reincarnation—being reborn in this world again and again? (% agree)	29
(Pew 2009) Believe in reincarnation, that people will be reborn...again and again (% agree)	19
(Preservice educators 2007) ^b Reincarnation really happens (% agree)	20
(NSF 2008) ^c Would you say that astrology is very scientific, sort of scientific, or not at all scientific? (% very or somewhat)	26
(Pew 2009) Do you believe astrology, or that the position of the stars and planets can affect people's lives? (% agree)	19
(Preservice educators 2007) Astrology is an accurate predictor of future events (% agree)	15
(GSS 2008) Do you believe in the supernatural powers of deceased ancestors? (% yes)	25
(Pew 2009) Ever felt that you were in touch with someone who has already died? (% yes)	26
(Preservice educators 2007) It is impossible to communicate with the dead. (% disagree)	49
(NSF 2001) Some of the unidentified flying objects that have been reported are really space vehicles from other planets (% agree)	28
(Preservice educators 2007) UFOs are actual spacecraft from other planets (% agree)	11
(Pew 2009) Have you ever consulted a fortune-teller or psychic? (% agree)	17
(Preservice educators 2007) Some people can predict future events by psychic power (% agree)	28
(Pew 2009) Have you ever seen or been in the presence of a ghost? (% agree)	15
(Preservice educators 2007) Ghosts really exist (% agree)	37
(Pew 2009) Do you believe in the "evil eye" or that certain people can cast curses or spells that cause bad things to happen to someone (% agree)	11
(Preservice educators 2007) An ancient curse on the tomb of the Egyptian pharaoh King Tut actually kills people (% agree)	8

^a 2008 General Social Survey, in-person national probability sample surveys

^b Depending on the question, base ns for the preservice educator sample range from 652 to 659

^c The NSF Surveys module in the 2008 General Social Survey is a *different sample module* than the 2008 "GSS" questions on, for example, reincarnation

We wondered whether "uncertain" responses were a socially desirable form of mild agreement on "Creatures", "Magic" or "Extraterrestrials" items. After all, despite their legendary longevity, we know of no scientific evidence supporting "Bigfoot", astrology, or extraterrestrials squirreled away from Roswell, New Mexico. One-fourth of preservice teachers were uncertain whether "Bigfoot" was "real". Nearly one-third weren't sure whether the Loch Ness monster was imaginary or magic was real. When uncertainty was added to agreement, many responses approached half of education majors, e.g., 19% were unsure whether psychics could predict the future and 28% agreed. In contrast, uncertainty responses on basic science facts did not exceed 10%. On the other hand, some readers questioned whether uncertainty choices indicated open-mindedness. We later address parallel indices constructed from the "uncertain" responses.

Preservice teachers rejected evolution but supported creationism. Most said evolution was "false" or disagreed that human evolution occurred *without* God. Bare majorities separately agreed that evolution *and* creationism should be taught in public schools. 25% of college-educated adults (Pew Forum on Religion and Public Life 2009) chose a "supremely guided" intelligent designer, as did 32% of education majors. 25% of Pew adults and 30% of preservice educators agreed that humans were originally created in their present form. Majorities of students also agreed that God created Adam and Eve. Proportionately as many believed scientific evidence supported creationism as believed humans developed from earlier species and nearly half endorsed a form of "irreducible complexity".

Table 3 Preservice educators' distribution of pseudoscience items (minimum $n = 639$)

Survey item	Agree (%)	Disagree	Other	Total (%)
a Evolution support				
Earth <i>very</i> old	64	14	22	100
Evolution correctly explains	36	46	18	100
Evolution occurred without God	14	69	17	100
Teach evolution in public schools	54	32	14	100
Humans developed from earlier species	43	57	0	100
b (Young Earth) Creation Support				
Evidence anti evolution pro <i>Bible</i> (both items)	41	32	27	100
Adam Eve created by God	69	16	15	100
God created humanity last 10,000 years	30	35	35	100
Teach <i>Bible</i> account creation in public schools	52	35	13	100
c Intelligent Design Support				
Humans complicated intelligent designer	46	29	25	100
Evolution not only theory to teach	68	21	11	100
Intelligent designer created humanity	32	40	28	100
d Creatures				
No Loch Ness Monster	58	12	30	100
Bigfoot is real	8	67	25	100
e Magic				
Magic really exists	18	51	31	100
Psychic powers	28	53	19	100
Astrology accurate future events	15	63	22	100
No psychic powers	56	27	17	100
Astrology accurate predictor personality	16	65	19	100
f Extraterrestrials				
Aliens built ancient monuments	5	83	12	100
UFOs spacecraft other planets	11	60	29	100
Aliens visited earth in the past	9	63	28	100
Government hiding info about aliens	18	47	35	100

Notes: a Mean 2.09, $s = 1.54$, $n = 658$; b Mean 2.29, $s = 1.74$, $n = 660$; c Mean 1.42, $s = 1.06$, $n = 662$; d Mean 0.20, $s = 0.47$, $n = 656$; e Mean 1.03, $s = 1.25$, $n = 658$; f Mean 0.43, $s = 0.85$, $n = 659$

3.4 Multivariate Analyses on the Preservice Teacher Sample

We conducted multiple regression analyses using gender, major, Oxford index score, the probability question, grade point average (GPA) and religiosity as predictors for all six indices. Gender, major, and religious denomination (mainline, fundamentalist, charismatic, none) were entered as dummy variables.

Although drawing causal inferences from observational rather than experimental data can be difficult, suggestions exist (Rosenberg 1968; Schneider et al. 2007) for ordering variables, e.g., gender *temporally precedes* beliefs and elementary school science exposure precedes college beliefs and attitudes. Although anecdotal accounts suggest that learning about evolution has led some to change their religious beliefs, religious practices and general denomination tend to be rooted in early family experiences. In any event, we

Table 4 Predicting evolution, “creationism” and “intelligent design” indices

Criterion variable	Evolution		“Creationism”		“Intelligent design”	
	<i>B</i>	Beta	<i>B</i>	Beta	<i>B</i>	Beta
Gender ^a	-0.38	-0.10**	0.24	0.05	0.12	0.05
Majors ^b						
Science Education	0.73	0.08**	-0.35	-0.04	-0.34	-0.06
Social Studies Education	0.50	0.12***	-0.21	-0.04	0.05	0.02
English Education	0.10	0.02	-0.26	-0.05	-0.13	-0.04
Mathematics Education	0.22	0.04	-0.13	-0.02	-0.05	-0.01
Physical Education	0.03	0.01	0.08	0.01	-0.09	-0.02
Coin toss question	-0.17	-0.04	0.27	0.06	0.09	0.03
Oxford Items index	0.14	0.14***	-0.14	-0.12***	-0.01	-0.02
Grade Point Average	0.04	0.02	-0.08	-0.04	0.06	0.04
Religious Denomination ^c						
Fundamentalist	-0.49	-0.14***	0.81	0.20***	0.32	0.13***
Charismatic	-0.63	-0.12***	0.46	0.08*	0.59	0.17***
None	-0.01	-0.00	-0.32	-0.07	-0.03	-0.02
Religious importance	-0.23	-0.46***	0.26	0.44***	0.12	0.33***
<i>R</i>		0.65		0.65		0.48
<i>R</i> ²		0.42**		0.42***		0.23***
<i>n</i>		618		618		620

* $p < .05$, ** $p < .01$, *** $p < .001$

^a Coded as a dummy variable with female = 1, since women were the vast majority of education majors

^b Coded as dummy variables with Elementary Education major as the omitted or reference category

^c Coded as dummy variables with “Mainline” as the omitted or reference category

realize that causal order is ambiguous in some cases (e.g., Wiccans and strict *Biblical* literalists may balk at majoring in science education).

Regressions for the Evolution, Creation, and Intelligent Design indices are presented in Table 4. Together, predictors explained 42% of the variance in evolution or creation support and 23% of the variance in intelligent design scores. Compared to women or elementary education majors, men, science or social studies education majors endorsed more evolution items. Education majors with higher science knowledge scores endorsed more evolution items and rejected more creation items.

Overall, religiosity measures were the largest predictors of the evolution and creationism indices. Self-identified fundamentalist or charismatic Christians (compared with “mainline” students) more often rejected evolution and endorsed creationism or intelligent design. The higher a student rated personal religious importance, the more s/he accepted creationism or intelligent design, and rejected evolution. Self-rated religious importance was a more efficacious predictor than general denomination.

In contrast, religiosity and other factors had low and erratic relationships with other pseudoscience measures. Table 5 shows that all predictors “explained” only 4% of the variation in the Creatures or Magic indices and 6% in the Extraterrestrial index.

Education majors who highly rated religious importance more often rejected fantastic beasts, while fundamentalists more often rejected magic or psychics. English education majors more often rejected “Magic”, as did students with higher GPAs. Men or students

Table 5 Predicting “creatures”, “magic” and “aliens” indices

Criterion variable	“Creatures”		“Magic”		“Extraterrestrials”	
	<i>B</i>	Beta	<i>B</i>	Beta	<i>B</i>	Beta
Gender ^a	-0.09	-0.07*	0.13	0.04	-0.36	-0.16***
Majors ^b						
Science education	0.18	0.07	-0.09	-0.01	0.05	0.01
Social studies education	-0.04	-0.03	-0.16	-0.05	-0.07	-0.03
English education	0.02	0.02	0.31	-0.08*	0.01	0.01
Mathematics education	0.04	0.02	0.05	0.01	0.03	0.01
Physical education	0.09	0.05	-0.10	-0.02	0.02	0.01
Coin toss question	-0.03	-0.02	-0.16	-0.05	0.06	0.03
Oxford items index	-0.01	-0.03	-0.05	-0.06	-0.01	-0.02
Grade point average	0.02	0.04	-0.12	-0.08*	-0.10	-0.09*
Religious denomination ^c						
Fundamentalist	-0.02	-0.02	-0.38	-0.13**	-0.14	-0.07
Charismatic	0.00	0.00	-0.05	-0.01	-0.13	-0.05
None	0.02	0.02	-0.09	-0.03	-0.05	-0.02
Religious importance	-0.02	-0.11*	-0.01	-0.01	-0.02	-0.06
<i>R</i>		0.20		0.19		0.24
<i>R</i> ²		0.04*		0.04*		0.06***
<i>n</i>		614		616		616

* $p < .05$, ** $p < .01$, *** $p < .001$

^a Coded as a dummy variable with female = 1, since women were the vast majority of education majors

^b Coded as dummy variables with Elementary Education major as the omitted or reference category

^c Coded as dummy variables with “Mainline” as the omitted or reference category

with lower grades more often endorsed “alien visitation”. Given the differences between Tables 4 and 5, the results suggest that distinct clusters of pseudoscience belief may exist. In contrast, highly correlated indices taken as a whole could signify an overall gap in the ability to critically evaluate pseudoscience “evidence”.

3.5 Correlations Among Indices

We show correlations among all six indices in Table 6. Bivariate correlations are below the diagonal to the left. Partial correlations, controlling gender, GPA, science or elementary education major, Oxford score, basic religious denomination, and self-rated religious importance are above the diagonal to the right. Partial correlations help assess which indices may conceptually group together and which bivariate correlations may simply have been due to common causes such as science knowledge or religiosity.

Correlations among the Creatures, Magic and Extraterrestrials indices were modestly positive, statistically significant, and remained so even with controls. Creation and intelligent design indices positively correlated while evolution initially negatively related to either ID or Creationism (all $p < .001$). However, *partial correlations* were low between evolution and ID or creation measures, suggesting that common correlates such as religiosity lay behind the original creationism-evolution dichotomy in our results, rather than some kind of ideology that is independent of religious beliefs.

Table 6 Zero order^a and partial^b correlations among evolution and pseudoscience indices

	Evolution	Creationism	Intelligent design	Creatures	Magic	Extraterrestrials
Evolution		-.19***	-.07	.06	.12**	.18***
Creationism	-.50***		.33***	-.02	-.00	.01
Intelligent design	-.26***	.47***		.05	.04	.06
Creatures	.16***	-.11**	-.01		.27***	.28***
Magic	-.04	-.16***	-.13***	.17***		.30***
Extraterrestrials	.23***	-.07	.01	.32***	.16***	

* $p < .05$, ** $p < .01$, *** $p < .001$

Minimum $n = 654$ for bivariate correlations; 615 for partial correlations

^a Zero-order correlations are below the diagonal and to the left

^b Partial correlation coefficients (controlling gender, science education major, elementary education major, grade point average, Oxford item score, basic religious denomination, and self-rated religious importance) are above the diagonal and to the right

Preservice educators who agreed with evolution items *also* endorsed fantastic beasts or extraterrestrials. Even with controls, evolution supporters continued to suspect alien visitation. Those endorsing creationism tended to *reject* aliens, magic or astrology although these weak, but statistically significant, correlations vanished when controlling variables such as general denomination.

3.6 Levels of Uncertainty

We also built indices summing the number of “uncertain” responses for each topic area, and then repeated the regression analyses shown in Tables 4 and 5 for the “uncertain indices” (tables are available from the authors upon request). Predicting uncertainty was far less efficacious than predicting support. No regression coefficients reached statistical significance for the Evolution or Creatures indices. Although isolated coefficients were statistically significant (e.g., science education majors and students with higher GPAs were more uncertain about extraterrestrials) the total explained variance was essentially zero for the Magic and Extraterrestrial measures.

Women more often were unsure about creationism. Fundamentalists or those with no affiliation—probably for different reasons—were less unsure about *Biblical* creation than mainline denomination members, as were those who rated religion highly. Education majors who felt religion was very important were less unsure about Intelligent Design.

4 Discussion

Although preservice teachers will have more influence on students than the “average US adult”, they were comparably knowledgeable on *very* basic science knowledge, in their rejection of evolution and in their acceptance of creationism or intelligent design. Most elementary educators will teach science and these preservice teachers were more likely to reject evolution. Their future pupils seem likely to have a shaky foundation for later science classes, and could find it difficult to reconcile the more “*Biblical*” science they may have received in grade school with the science they are asked to learn in middle and

high school or in college. Such “knowledge conflicts” may aggravate the “watershed” in science interest often noted to begin in middle school.

Preservice teachers also may have lacked the critical thinking skills to unequivocally reject astrology or alien landings. Students who agreed with one form of [non-creation] pseudoscience tended to support others. Accepting evolution actually was linked to pseudoscience items about extraterrestrials or psychics. If future teachers tend to uncritically accept information from media and political figures (e.g., doctored photos of the “Loch Ness Monster”) without weighing its scientific feasibility, such tendencies may transfer to their classrooms, one reason why AAAS Project 2061 Benchmarks emphasize critical thinking so strongly. Thus, our results indicate gaps teacher education can address (see below).

College major, GPA and science knowledge protected against pseudoscience only so far. Future science educators endorsed evolution more. More “knowledgeable” education students more often accepted evolution and rejected creationism. Although predicting evolution support from gender, college major, GPA, science knowledge and religious variables was relatively robust, as was predicting creationism or ID, these predictors had almost no net relationship with the Creatures, Magic, or Extraterrestrials indices. Students with lower GPAs slightly more often agreed with “Magic” or “Extraterrestrials” items. Neither major nor science knowledge provided much inoculation against the lures of psychics, alien landings or fantastic creatures. Indeed, science educator majors or those with better grades were more uncertain about extraterrestrials constructing ancient monuments or being hidden by the government.

Religious denomination or self-rated religiosity had mixed effects. Compared with “mainline” Christians or Jews, fundamentalist or charismatic Christians more often rejected evolution and endorsed *Biblical* creation or intelligent design. Self-rated religiosity was the largest predictor of evolution-creationism attitudes.

However, if anything, religious variables related to *rejecting* pseudoscience beliefs, such as fantastic beasts or psychics. This occurred in the regressions and in bivariate correlations between creationism or ID and items about magic, astrology or psychics. The contrast between how religious factors related to evolution-creationism and how they related to other indices is consistent with some prior suggestions that the creationism-evolution debate is a civic science literacy anomaly. For example, Miller (Miller 2010) notes that American creationism beliefs are largely dependent on inerrant religiosity and do not represent overall US science knowledge.

Correlations showed some support for conceptualizing pseudoscience beliefs as distinct topical clusters. Evolution, creationism and intelligent design correlated strongly enough to suggest that a single dimension with probable roots in inerrant *Biblical* doctrine underlies these items. Conversely, even with several statistical controls, the Creatures, Magic, and Extraterrestrials indices positively, if modestly, correlated among themselves. However, correlations across the two separate sets of indices were erratic.

We caution that three-quarters of these preservice teachers were from the Southeast and 39% identified as fundamentalist or charismatic Christians (albeit at a large secular university). How much region may relate to pseudoscience belief awaits other research on education majors, although studies of general public opinion suggests American Southeast and Midwest adults tend to have more traditional religious and political attitudes than East or West Coast residents (Davis and Smith 2009).

We would also like more purified evolution, creation, and intelligent design measures. For example, one item may have confused young Earth creation with more typical ID sentiments. “Theistic evolution,” too, could use its own items. Since most major

denominations have theologically “interpretative” versus “inerrant” wings, more precise denominational measures also may be useful. Recall, however, that religious variables here contributed to explaining nearly half the variance in the evolution and creationism indices and about one-quarter of that in the intelligent design measure. Even somewhat adulterated religious measures can aid in studying pseudoscience beliefs.

5 Conclusions and Implications

Year by year science and technology grow more complex. Even well educated professionals can have trouble deciphering nuances outside their own fields. Ironically, scientific or technological progress may *contribute* to pseudoscience belief because more specialized knowledge of processes in, for example, stem cell research (now being hawked in cosmetic creams) or genetically engineered foods is necessary to distinguish feasibility from fantasy. Indeed the greater the societal level of science and technology achievement, the greater the onus on colleges and universities to help graduate teachers in *all disciplines* able to distinguish between science and pseudoscience.

The rough distinction between two sets of pseudoscience areas suggests that rote learning among future educators, whether from coursework or religious training, affects evolution and *Biblical* creation beliefs but not judicious appraisals of other areas. Most high school and college biology classes address evolution. But evaluative skills learned in science classrooms about evolution apparently do not generalize to rejecting costly or even delusional forms of pseudoscience. For example, the possibly compartmentalized nature of very basic science knowledge showed in the Oxford index’ prediction of evolution or creationism, but its negligible effects on endorsing *or even uncertainty about* fantastic creatures, visiting extraterrestrials, or magic.

The intercorrelations among the Creatures, Magic and Extraterrestrials indices and the erratic correlations these have with evolution may be due to poor critical thinking skills. And here is where cognitive research—and science education faculty—can help. Cognitive research suggests using pseudoscience beliefs to teach science methods and critical thinking, e.g., presenting some aspects of creationism can help teach biological inquiry (Verhey 2005), showing that a “publicly controversial theory [evolution] is not necessarily a scientifically weak or...controversial theory” (Nelson 2000: 19) or that science follows different evidentiary rules from those used by attorneys, journalists or debate teams (Losh 2003). Discussing “subliminal persuasion” may help introduce methods, e.g., control groups, in research (Pratkanis 1992).

We suspect that course segments conducted or designed by science education faculty for *all* education majors may help future teachers distinguish between “real” and “ersatz” science. For example, science rules of evidence can be used to tackle the veracity of phenomena such as ghosts, astrology or extraterrestrials.

On the other hand, Chancey (2007) and Verhey note that presentations including creationism in *K-12 schools* must proceed cautiously (although recall Berkman et al. found one-fourth of their high school biology teacher sample *already* report teaching creationism). Willingham (2007) also reminds us that both domain factual knowledge and inquiry methods are required to successfully teach critical thinking.

Our further research will examine how course experiences (e.g., college biology) and media variables (e.g., exposure to science fiction) relate to preservice teacher beliefs, analyses precluded here for space reasons. However, we believe *education faculty* also need instruction. As Feder (1984: 535) points out “ignoring extreme...claims that appear

in popular media may be construed by students as acquiescence. Lack of response may be interpreted as inability to respond.”

Post-secondary faculty may feel squeamish or that addressing topics such as extraterrestrials in the classroom is illegitimate. They may believe only a few “loonies” endorse such beliefs and do not realize how much cognitive confusion over how to evaluate fantastic claims exists among their students. We hope data presented here illustrates how popular even materially ludicrous claims can be.

Faculty may justifiably worry about presenting such material in ways to illuminate science rather than reinforce ersatz science. However, the alternative is to delegate pseudoscience “instruction” to the popular media, which fail “to rely on scientific evidence and method to critically evaluate...findings. Positive findings are emphasized and null results rarely reported” (Pratkanis 1992). Teacher educators must address these costly science “alternatives” and educating *all* preservice teachers, not just future science educators is a solid way to start. That way, the only creatures lurking in the classroom will be the ones that nature provides.

Acknowledgments This research was funded in part through an American Educational Research Association grant REC-0310268, National Science Foundation grant 0532943 and the National Science Foundation Division of Materials Research through DMR-0654118. Thanks also to Raymond Eve, Ken Feder, Ryan Wilke, Alice Robbin, Martin Bauer, Bob Bell, Jaqui Falkenheim, Nick Allum, and several reviewers for insight, greater clarity and assistance.

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