J Sci Educ Technol (2011) 20:579–591
DOI 10.1007/s10956-011-9297-0

The Influence of Education Major: How Diverse Preservice Teachers View Pseudoscience Topics

Susan Carol Losh · Brandon Nzekwe

Published online: 19 April 2011

Abstract Pseudoscience beliefs (e.g., astrology, ghosts or UFOs) are rife in American society. Most research examines creation/evolution among liberal arts majors, general public adults, or, infrequently, middle or high school science teachers. Thus, research truncates the *range* of ersatz science thinking and the samples it studies. We examined diverse beliefs, e.g., extraterrestrials, magic, *Biblical* creation, and evolution, among 540 female and 123 male future teachers, including 325 elementary education majors. We study how these cognitions related to education major and, because popular media often present pseudoscience "information", student media use. Future elementary educators most often rejected evolution and endorsed "creationism" or Intelligent Design. Education majors held similar beliefs about astrology, UFO landings, or magic. Compared with other education students, elementary education majors watched less news or science television and read fewer popular science magazines. However, religious and media variables explained more variation in creation/evolution beliefs than education major. We discuss implications of our findings for elementary school science education and how teacher educators may be able to affect pseudoscience beliefs among their elementary education students.

Keywords Pseudoscience beliefs · Pseudoscience attitudes · Preservice teachers · Elementary school science educators

S. C. Losh (✉) · B. Nzekwe
Department of Educational Psychology and Learning Systems, Florida State University, Tallahassee, FL 32303-4453, USA
e-mail: slosh@fsu.edu

Introduction

Pseudoscience beliefs (e.g., astrology, ghosts or UFOs) thrive in American society. We define such beliefs as cognitions about material phenomena that, although they lay claim to be 'science,' use non-scientific evidentiary processes including authoritative assertion, anecdotes, or unelaborated 'natural' causes (Losh et al. 2003). Most pseudoscience research examines the creation/evolution "controversy"[1] among liberal arts majors, general public adults, or, less frequently, middle or high school science teachers. Both the samples of participants and of pseudoscience domains are much too restricted.

Because pseudoscience damages health, drains cash, and undermines science education, the creation/evolution focus is overly limited. A frequent academic response to research on pseudoscience belief is derisive laughter, with perhaps a plea for enhanced science education. Yet "alternative medicine" or unscientific opposition to modern medicine can literally kill.[2] Psychics are expensive and encourage fatalism (Stollznow 2009). Tales of extraterrestrial abduction substitute fantasy for natural explanations.

[1] We refer here to social or political, *not* scientific, controversy, important especially when we consider the proliferation of supposedly "controversial topics" in current American politics about school science.

[2] Jenny McCarthy, an entertainer, has extensively written and spoken about the "dangers", particularly autism, supposedly linked to vaccines (an assertion lacking systematic evidence). One pundit created the "Jenny McCarthy Body Count" website using data from the Centers for Disease Control, showing time series data on the incidence of different diseases in the USA. Between June 2007 and February 2011, he estimated at least 74,000 illnesses and over 600 deaths that could have been prevented by vaccination, see: http://www.jennymccarthybodycount.com accessed February 6, 2011.

This is an especially critical time to study such topics. Since the 2005 Dover, Pennsylvania legal decision, which rejected teaching "Intelligent Design" in public school science classes because of its religious connotations, the sphere of "school science politics" has widened. For example, in part to circumvent American laws about the separation of church and state, and under the guise of teaching "critical thinking", in January 2011, both legislative chambers in the state of Oklahoma introduced bills that would mandate teaching "challenges" to evolution, climate change, stem cell research and cloning in every "publicly funded Oklahoma school" (National Center for Science Education 2011). A proposed 2011 theme park in Kentucky, poised to receive taxpayer rebates, asserts that Noah's Ark rescued dinosaurs and unicorns.

Scholars also usually neglect studying pseudoscience beliefs among *educators in different disciplines*. That's a big mistake because teachers reach far more people than the average adult in national science literacy surveys. Most American adults lack a college degree (including an Associate of Arts), thus K through 12 teachers disproportionately influence civic science literacy (Losh 2011). General elementary educators in most US states teach science in addition to reading and mathematics, thus establishing the foundation for more advanced science instruction. However, they are poorly prepared compared with middle or high school science teachers, making it especially important to study pseudoscience support among elementary school teachers.

Thus, *this study compares diverse pseudoscience beliefs among preservice teachers in different majors.* We examined beliefs, e.g., magic or *Biblical* creation, among several hundred preservice teachers, including over 300 future elementary educators. In addition, because popular media often present pseudoscience "information", we included student exposure to several different media as control variables.

Research Questions

- What is the extent of pseudoscience support among a sample of student teachers?
- What are the main contributing factors to student teachers' pseudoscience beliefs?
- How do media choices among student teachers relate to pseudoscience beliefs?

Pseudoscience support in America

A common stereotype is that pseudoscience supporters are mentally ill, dim-witted or undereducated. Although extremists exist among any set of believers, studies of both students and adults belie these stereotypes (e.g., Spanos et al. 1993). Pseudoscience beliefs are simply too prevalent in the American general public (e.g., Davis and Smith 2009) to be the bailiwick of an "unbalanced" few.

For example, nearly *two-thirds* of adults in the national Pew (2009b) landline and cellular Random Digit Dial survey reported *at least one* of the following: endorsing reincarnation (24%), "spiritual energy" in physical entities, such as trees (26%), astrology (25%), or the "evil eye" (16%); personally communicating with the dead (29%), seeing or experiencing a ghost (18%), or visiting a fortuneteller or psychic (15%). In a separate survey for the American Association for the Advancement of Science (Pew 2009a), 87% of scientists but only 32% of the general public supported evolution.

Teachers are not immune: Eve and Dunn (1990) found notable minority support for contacting the dead or psychics (each 29%) among *life science and biology high school teachers.*[3] One fourth endorsed *Biblical* creation and 45% agreed God created Adam and Eve as the first human beings. Twenty years later, 25 percent of the nearly 1,000 US secondary biology teachers Berkman and Plutzer studied (Berkman et al. 2008; Berkman and Plutzer 2010) *taught Biblical* creation (half of those deemed it a valid alternative to evolution) and 16% identified as "Young Earth Creationists". At least some research indicates that college students who were taught "creationism" in high school are resistant to learning about evolution in college (Moore and Cotner 2009).

Given the "watershed" in science interest that occurs among many middle and high school students, it seems imperative to further study elementary educators who teach science. For example, 39% of Bloom's (1989) Canadian preservice teachers described themselves as "creationists" and these future elementary educators seemed to have a anthropocentric view of evolution that culminated in human beings.

Elementary Educators and Science

We have less research on elementary school teachers than for those in middle or high school, but enough exists to warrant some tentative conclusions. American elementary educators face a teaching schedule crowded with reading, math, history, and electives—and most must teach science as well. As students, many were uneasy about their own science classes; they lack confidence; and are confused about the nature of science (NOS; Appleton and Kindt 1999; Bloom 1989; Skamp and Mueller 2001). For example, when asked about NOS future elementary educators

[3] The National Science Teachers Association provided the population list for the national sample.

most often mention "discovery" of a set of fixed and "underlying truths" (often acquired through "hands on activities"; e.g., Abell and Smith 1994). Hands on activities are viewed as indicators of "good science teaching" (Skamp and Mueller 2001) while concepts such as "theories", scaffolding or constructivism are less well known and muddled[4] (Abell and Smith 1994; Akerson et al. 2008; Bloom 1989; Jones et al. 2005; Skamp and Mueller 2001). Under such circumstances, teaching science can fall to the end of the elementary school curriculum.

In part, low science exposure fosters these conflicted and muddled cognitions among elementary school faculty. In many states, as students they elected *only one* elementary school science methods course in addition to liberal arts requirements. The latter can be *just two* science courses (one with lab) and need not be "traditional" science (e.g., biology; see also Bloom 1989; Skamp and Mueller 2001 for United Kingdom countries). At one large state university, liberal arts science requirements can be met with courses such as "The Evolution of Human Sexuality" or "Dinosaurs and Disasters on an Evolving Earth". While undoubtedly appealing, such courses do little to assist elementary school teachers to teach science, except, perhaps, to illustrate the unit on dinosaurs.[5]

Unfortunately, as one cognitive researcher explains (Willingham 2007), teaching critical thinking, which comprises part of NOS instruction, and forms part of science methods or educational psychology curricula, fails to improve evaluative skills *unless the student also possesses good content knowledge*. In other words, it will be difficult for a future elementary school teacher to know and apply the nature of science if they have not had even one college course in a traditional field such as biology or chemistry.

Some Sources of Pseudoscience Belief

Cognitive

Our background is in social psychology heuristics (e.g., Carlston 2010; Fiske and Taylor 1991). We believe pseudoscience can appeal because individuals poorly understand the nature of science (NOS) and many pseudoscience beliefs seem plausibly related to current science developments (e.g., "stem cells" in new cosmetic creams.) Some "beyond the fringe" science (Rosenthal 1993) can resemble "fringe" or even the "frontiers" of science. Elementary and secondary educators can be confused about NOS and have difficulties separating a scientific theory from authoritative (e.g., *Biblical*) or other assertions (e.g., Berkman et al. 2008; Eve and Dunn 1990).

Education and Religiosity

Although public opinion surveys repeatedly find that more educated adults support evolution and reject creationism or Intelligent Design (ID) to explain human origins, formal education relates inconsistently to other pseudoscience support. Those who have greater familiarity with basic science factual material, who tend to be more educated, more often reject *traditional* pseudoscience (e.g., *Biblical* creation or astrology; Losh et al. 2003; Losh 2011). On the other hand, endorsing some forms of alternative medicine, clairvoyance, or extraterrestrial visits is either unrelated to education—or *rises* with formal schooling (National Science Board 2010, Chapter 7; Pew 2009a, b).

The same sources indicate that religiosity plays a critical role in beliefs about evolution. *Biblical* literalists and adults who define themselves as highly religious often reject evolution and endorse *Biblical* creation (Pew 2009a). Interestingly, however, these same adults also *less* often support other forms of pseudoscience, such as reincarnation, astrology, contacting the dead, or ghosts (Pew 2009a, b). We include two basic measures of participant religion in our analyses.

Media

Perhaps pseudoscience popularity is to be expected, given its extensive media coverage. Science *and* pseudoscience are popular topics among US adults (National Science Board 2010, Chapter 7). "Science channels" on cable television, for example, include programs on "ghost hunters"; popular science magazines sometimes endorse "natural cures" or speculate about space alien landings. Because Americans voraciously consume media, studying how such beliefs relate to media exposure may provide suggestions for science teachers or teacher educators about how to tackle pseudoscience topics.

Personal beliefs and media consumption are clearly reciprocal. People select media that reflect and presumably reinforce their interests (e.g., Erikson and Tedin 2011). Nevertheless, *cultivation theory* (e.g., Gerbner 1987; Morgan and Shanahan 1999) proposes that media slightly, but consistently affect consumer perceptions, perhaps through message repetition and the relatively restricted points of view that appear on commercial TV. For example, the media and heavier television viewers miscalculate risk (Singer and Endreny 1993).

[4] A second science elementary education methods course or addressing the nature of science in a second [non-science] education course may help (Akerson et al. 2008; Gustafson and Rowell 1995).

[5] Among our participants for this study, 19 percent agreed, humans and dinosaurs lived at the same time.

Methods

Participants were 540 female and 123 male junior and senior education majors (median age 20) electing Educational Psychology or Assessment courses (required for state certification) during 2007 at a large Southeastern state university. Nearly half (49%) were general elementary education majors; most of them will teach science to their young pupils in the near future. The other future teachers planned careers in middle school or high school specialized fields in: social studies (16%), English (13%), math (9%), 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 duplicates. Program coordinators or the College Dean confirmed disciplinary major enrollments.

Sixty percent of women majored in elementary education; only 8% were in math education and 3% were science education majors. Conversely, 9% of men majored in elementary education versus 35% in social studies education, 16% in math education, and 5% in science education ($X^2_{(5)} = 184.83$, $p < .001$). 83% of education majors learned evolution in high school—although 40% of that number also was taught "creationism", thus *one-third* remembered exposure to *Biblical* creation in their high school classes.

Students completed a *survey* with demographics and 88 items tapping science knowledge, pseudoscience belief, and attitudes about social issues, science (e.g., "science is too expensive") and religion[6] (Eve and Dunn 1990; Feder 1984; 1985/6). 10 of the 88 items were from the National Science Foundation (NSF) Surveys of Public Understanding of Science and Technology, and address *very* basic science knowledge; these have been used in probability sample surveys of US adults since 1988. Also administered in international adult surveys such as the *Eurobarometer*, they have been called the "Oxford items"; the items address facts taught in late elementary school and reviewed in middle school (Allum et al. 2008; National Science Board 2010).

Besides their brevity, we use these factual knowledge items because the NSF has extensively studied their intercorrelations and psychometric properties (Bann and Schwerin 2004).[7] The index built from the Oxford items has a history of predicting *traditional* pseudoscience attitudes in US general public samples of adults (Losh 2011).

We use 33 of the 40 pseudoscience belief items in six indices: support for (1) *Biblical* or "young Earth" creation; (2) "Intelligent Design" ("ID", distinguished from literal creationism); (3) evolution; (4) fantastic creatures, e.g., "Bigfoot"; (5) magic, psychics or astrology; and (6) extraterrestrials.[8] Each item was measured through a 4-point Likert scale, with "undecided, the available evidence is inconclusive" and "never heard of it" responses explicitly provided. We created indices to maximize the range of pseudoscience beliefs; we counted the number of agree strongly or agree somewhat responses per index and scored the percent correct for the Oxford items. Each index with its average inter-item correlation and reliability (coefficient α) is presented in Table 1.[9]

Among background factors, we included education major, and gender. Grade point average (GPA) was measured on a 6-point scale (1 = less than C to 6 = A/A-). We used two religiosity indicators: (1) general denomination: "Mainline" (non-evangelical Protestant or Catholic, e.g., Presbyterian; Reform Jewish, 50%); Fundamentalist Christian[10] (e.g., Southern Baptist Convention, 23%); Charismatic Christian (e.g., Assembly of God, 10%); or None (including atheist or agnostic, 17%) and (2) a self-rated 10-point religious importance item (very important = 10; median = 8). We created denomination from the student's self-definition (e.g., "agnostic") *and* sociological research on denominations (e.g., Davis and Smith 2009).

Several items assessed whether students read, accessed or watched 10 different media from never (1); rarely; sometimes; to often (4). We asked about: newspapers; television news; news magazines; popular science magazines; science TV programs; science fiction books; science fiction TV; books on pseudoscience (e.g., UFOs); books on creationism, or websites about extraterrestrials.

Results

We employ percentages and analyses of variance (ANOVA) or covariance (ANCOVA) in data analysis.[11]

[6] The questionnaire is available upon request from the first author (slosh@fsu.edu), or from Raymond Eve (eve@uta.edu) or Kenneth Feder (feder@ccsu.edu).

[7] This report is available by email from the first author (slosh@fsu.edu).

[8] The omitted seven items either had ignorance rates of at least 20 percent among these students (King Tut's curse; the lost continent of Atlantis; or the Shroud of Turin); resembled none of the other pseudoscience general topics (reincarnation; communication with the dead; or the Bermuda Triangle) or were so highly skewed that the item was basically a constant (time travel).

[9] For correlations among these indices, see Losh and Nzekwe (2011), Table 6.

[10] None of the participants identified as orthodox Jews or Muslims of any kind.

[11] We also reference bivariate correlation coefficients published earlier (Losh and Nzekwe 2011).

Table 1 Questionnaire items for study indices

Evolution (r-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-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-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.[a]

Creatures (fantastic beasts; r-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-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-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.

How long does it take the earth to go around the sun? [a) one day; b) one month; c) one year; d) 10 years; e) the earth does not go around the sun]

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

[a] Some "Intelligent Design" proponents will accept an "old earth"; others will not. The key here was the phrase "intelligent designer"

Following Rosenberg (1968) or Schneider et al. (2007), we assign causal precedence in these observational data to variables occurring earlier in time than current pseudoscience beliefs (e.g., gender; primary school science knowledge), or which have wide cognitive or affective ramifications (e.g., self-rated religiosity).

Later, we later present figures addressing mean pseudoscience belief index scores by education major using

Multiple Classification Analysis (MCA). For example, whether a future teacher supported literal *Biblical* creation was analyzed through ANCOVA by major, controlling gender, basic science knowledge, GPA, religious and media variables. The results compare unadjusted and adjusted (controlled) mean scores in a straightforward graph. MCA is a general linear model presentation tool that provides standardized beta coefficients for categorical predictors and metric regression bs (which we also standardized) for numeric predictors of a dependent variable. The betas represent deviations from the dependent variable mean score (e.g., "creationism" agreement) for each category of each categorical predictor.

Table 2 presents agreement, disagreement and "other" (nearly all "undecided") preservice teacher percentage distributions on the Evolution, Creation, Intelligent Design, Creatures, Magic, and Extraterrestrials indices. We found the levels of uncertainty striking as these college juniors and seniors "awaited more evidence" on topics, which, despite their longevity, have not accrued scientific support, such as astrology or the Loch Ness Monster. One-fourth of all future teachers were uncertain whether "Bigfoot" was "real". Nearly one-third weren't sure whether the Loch Ness monster was imaginary or if magic was real. When uncertainty was added to agreement, many responses approached half of our sample, e.g., 49% either agreed or were undecided whether "magic really exists" and 53% either agreed or were undecided that the American government was "hiding information…that UFOs are alien spacecraft." In contrast, uncertainty responses on basic science facts such as the Oxford items did not exceed 10%.[12]

Although two-thirds of participants agreed that the earth is very old, they *also* largely agreed that God created Adam and Eve and that evolution should not be the only theory about human origins taught in public schools. Table 3 presents mean scores from a one-way ANOVA on the pseudoscience indices, basic science knowledge and grade point average by education major. These *unadjusted* means on pseudoscience indices form the initial scores for the MCA analysis later presented in the figures.

Future elementary, English, math and physical education teachers more often rejected evolution while science and social studies education majors most often accepted it ($F_{5,629} = 11.39$, $p < .001$). Conversely elementary, English, math and physical education future teachers more often accepted young Earth creationism while science and social studies education majors rejected it ($F_{5,631} = 5.60$, $p < .001$). Elementary and math preservice teachers supported Intelligent Design slightly more, while future science educators mostly rejected it ($F_{5,633} = 3.42$, $p < .01$). Agreement with the Creatures, Magic or Extraterrestrials indices was low overall, and unaffected by education major.

The average future educator correctly answered 7.7 out of 10 Oxford items. Science education majors scored the highest (8.7). Elementary, English and math education majors all scored at the mean ($F_{5,637} = 3.59$, $p < .01$). Elementary educators had the highest GPA, while majors in Science or Physical Education had the lowest ($F_{5,636} = 4.76$, $p < .001$).

Future educators differed on other characteristics besides GPA, science knowledge or pseudoscience beliefs. Table 4 shows mean scores or percentages on background variables and media use by education major, using one-way ANOVAs to compare across disciplinary specialty.

There were no statistical differences by education major for belonging to a Mainline or charismatic religious denomination. However, Fundamentalist Christians were over represented among future elementary school and math teachers ($X^2_{(15)} = 24.80$, $p < .01$), while nearly one third of science education majors and about a quarter of physical education majors had no formal religious affiliation.

Education majors also differed in media choices. Table 4 also shows results from a set of one-way ANOVAs comparing the students on media use. Future teachers comparably read newspapers, pseudoscience books (e.g., The Bermuda Triangle), or books on "creationism". They watched science fiction TV about the same. Future science teachers, social studies, and elementary educators most often watched television news (physical education majors the least, $F_{5,635} = 5.71$, $p < .001$). Science, math and physical education majors read news magazines (e.g., *Time*) the least ($F_{5,626} = 5.39$, $p < .001$).

Science and social studies education majors most often read popular science magazines; elementary and math education majors read them the least ($F_{5,634} = 3.58$, $p < .01$). Future science educators most often watched science TV programs (e.g., "Nova", $F_{5,633} = 6.02$, $p < .001$) although English future teachers reported reading science fiction ($F_{5,626} = 3.81$, $p < .01$). Finally, although reading frequency varied little, future science, social studies, and physical education teachers reported accessing websites on extraterrestrials more often ($F_{5,636} = 2.30$, $p = .04$).

We focus on background and media variables, because, as Table 5 will show, religious and media characteristics are the most strongly related to pseudoscience beliefs. With

[12] In prior analyses, we combined agreement with uncertainty responses for indices. However it has been suggested that "uncertainty" could indicate "scientific skepticism". *We* doubt this explanation because of the centuries' duration of legends such as the Loch Ness Monster or "systems" such as astrology. However, creating "purified" agreement indices as we do here does not change the overall results or conclusions.

Table 2 Preservice educators' distribution of pseudoscience items (minimum n = 639)

Survey item	Agree (%)	Disagree	Other	Total (%)
Evolution support[a]				
Earth *very* 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
(Young Earth) Creation support[b]				
Evidence anti evolution pro *Bible* (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 *Bible* account creation in public schools	52	35	13	100
Intelligent design support[c]				
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
Creatures[d]				
No Loch Ness Monster	58	12	30	100
Bigfoot is real	8	67	25	100
Magic[e]				
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 predict personality	16	65	19	100
Extraterrestrials[f]				
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

[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

these variables controlled the effects of education major diminish considerably. Although we do *not* assign causal priorities to media use, because beliefs about "creationism", evolution or magic are reciprocally locked in a relationship with the media these future teachers read, view or access, we note that the effects of education major are small in comparison with media and religiosity variables.

We entered predictors for Table 5 in blocks, assessing the increment to η^2 first of student major (to maximize its potential impact), next for the Oxford items, GPA and religious variables, then for frequency of media access. *Total* η^2s are shown at the bottom of each index column. Background, knowledge, religiosity and media variables were the most efficacious at predicting about human origins, suggestive in predicting magical beliefs and not useful at all to predict beliefs about fantastic beasts or space aliens.

With other variables controlled, education major had a relatively minor effect on creationism or evolution indices, accounting for 4% of the variance in young Earth creationism, 3% in ID and 8% in evolution support. Major was unrelated to the other three indices. The Oxford items addressing basic science facts—and especially religious denomination and self-rated religiosity were the most influential, increasing the η^2 by 38% for "creationism", 20% for ID, and 34% for endorsing evolution. Finally media

Table 3 Science knowledge and pseudoscience mean index scores by education major

Education major-→	Elementary	Science	Social studies	English	Math	Physical education	All
Index mean agreement scores[a]							
(Young Earth) Creationism	2.5	1.1	1.8	2.1	2.4	2.3	2.3***
Intelligent design	1.5	0.7	1.3	1.3	1.5	1.2	1.4**
Support evolution	1.8	3.6	2.7	2.1	2.1	2.2	2.1***
Creatures	0.7	0.8	0.7	0.8	0.9	0.9	0.7
Magic	1.0	1.1	0.9	0.9	1.2	1.0	1.0
Extraterrestrial visitation	0.3	0.5	0.4	0.4	0.5	0.7	0.4
Oxford index	7.7	8.7	8.0	7.7	7.6	7.2	7.7**
GPA (6 = A/A-)	5.2	4.7	5.1	5.0	5.1	4.8	5.1***
Minimum n	315	23	103	80	57	46	624

[a] Probability levels from a one-way Analysis of Variance * $p < .05$; ** $p < .01$; *** $p < .001$

Table 4 Background and media variables by education major

Education Major-→	Elementary	Science	Social studies	English	Math	Physical education	All
% Female[a]	97	73	60	92	68	28	81***
%Mainline denomination	47	63	53	55	53	46	50
% Fundamentalist	27	0	18	18	35	19	23**
% Charismatic	11	5	8	10	5	11	10
% None	15	32	21	17	7	24	17*
Mean religious importance (10 = Very Important)	7.3	5.3	6.2	6.8	7.6	6.4	6.9***
Mean media access frequency[b]							
Read newspaper	2.5	2.4	2.7	2.5	2.4	2.4	2.5
Watch television news	3.0	3.4	3.2	2.8	2.7	2.6	2.9***
Read news magazines	2.1	1.8	2.3	2.4	1.8	1.9	2.1***
Popular science magazines	1.6	2.1	1.9	1.7	1.6	1.8	1.7***
Science television programs	1.3	2.1	1.5	1.3	1.3	1.5	1.4***
Science fiction books	1.7	1.9	1.8	2.1	1.8	1.5	1.8**
Science fiction television	1.3	1.7	1.4	1.4	1.4	1.3	1.3
Pseudoscience books	1.2	1.4	1.4	1.3	1.3	1.3	1.3
Biblical creation books	1.2	1.1	1.1	1.2	1.1	1.1	1.2
Extraterrestrial websites	1.1	1.3	1.3	1.1	1.2	1.2	1.2*
Minimum n	315	21	101	80	55	46	623

[a] Probability levels are all from a one-way Analysis of Variance * $p < .05$; ** $p < .01$; *** $p < .001$

[b] Response alternatives were: *1* Never, *2* Rarely, *3* Sometimes, *4* Often

exposure was associated with a 5% increment to the "creationism" η^2, a 6% increment to ID variance, and a 5% increment to the evolution index. Major did not relate to the Magic index, but an inspection of means showed that those rating religious importance the least—or the most—important, who relatively frequently accessed extraterrestrials websites, or read pseudoscience books more often endorsed magic or astrology items.

The multivariate results in Table 5 suggest that, compared with the average preservice teacher in our sample, evolution supporters, in addition to more often majoring in science education or social studies education, were generally more open to media, whether newspapers, TV or magazines. They more frequently chose science magazines or television programs—or even websites about space aliens. They also were more often nonreligious. In contrast, "creationism" or ID supporters more often belonged to fundamentalist or charismatic Christian denominations, rated religious importance highly and accessed news magazines, science TV programs or extraterrestrial websites much *less* often. They did, however, more often read books about *Biblical* creation. We revisit these issues in our discussion because

Table 5 Analysis of covariance standardized partial multiple classification analysis (MCA) coefficients on pseudoscience indices

Dependent (criterion) variable → Predictor	*Biblical* creation	Intelligent design	Support evolution	Creatures	Magic	Extraterrestrials
Education disciplinary major[a]	.04***	.07**	.12***	.10	.09	.05
Gender	.05**	.06*	.08***	.02	.09	.08
Oxford items index	.12***	.09	.18***	.11	.12	.12
Overall grade point average	.07**	.08	.05	.07	.09	.07
Religious denomination	.21***	.18***	.14***	.07	.11	.04
Religious importance	.42***	.32***	.47***	.11	.20**	.14
Media frequency						
Newspapers	−.00	−.02	.10**	−.05	−.12*	.04
Television news	−.06	−.07*	.11***	.04	.11*	−.01
News magazines	−.22***	−.09*	.12**	.01	.09	−.05
Popular science magazines	−.01	−.07	.12***	.04	−.09	−.01
Science television programs	−.15***	−.08	.14***	.03	−.09	.01
Science fiction books	−.08*	.00	−.01	.02	.08	−.02
Science fiction television	−.02	.04	−.02	−.05	.03	−.00
Books on pseudoscience (NEC)	−.13***	−.03	.14***	.07	.14**	−.07*
Books on *Biblical* creation	.17***	.19***	−.09**	−.05	.01	.04
Websites about extraterrestrials	−.13***	−.15***	.14***	.05	.22***	.06
n	575	576	573	571	573	573
R^2 analogue[b] Education Major only	.04***	.03**	.08***	.01	.01	.01
R^2 analogue adding controls but not media	.42***	.23***	.42***	.02	.04	.06
R^2 analogue adding media variables	.47***	.27***	.47***	.05	.14***	.06

Coefficients are standardized betas from Multiple Classification Analysis for the factors or standardized b coefficients for the covariates

[a] Standardized betas for education disciplinary major or religious denomination are for the *entire set* of variable categories

[b] From Multiple Classification Analysis, analogous to η^2 in analysis of covariance

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

they suggest that educating future elementary school teachers more effectively on teaching science will probably involve more than simply having them take more courses, although that too, would be helpful.

Finally, in Figs. 1, 2 and 3, we present the unadjusted and adjusted mean scores by education major on support for *Biblical* creation, ID or evolution,[13] using the deviation scores in the final ANCOVAs and the associated Multiple Classification Analyses. These graphs show that once background (especially religious and media) variables are controlled, the initial strong effects of majoring in science education (and somewhat less so in social studies education) "flatten out" and exert little final influence on these beliefs. *Thus, it's not so much that college major influences creation-evolution beliefs, but rather the religious and media variables correlated with education major that relate to such endorsements.*

[13] Because education major did not influence beliefs about creatures, magic or extraterrestrials we do not present MCA graphs for these three indices.

Discussion, Conclusions, Implications

This study examined how preservice teachers' education major and other characteristics of future teachers related to several pseudoscience beliefs. We expected science education majors to support evolution and reject *Biblical* creation. Given skepticism among scientists about phenomena such as astrology or "creatures" such as Bigfoot, science education majors should reject those pseudoscience beliefs too. Because math is so intimately linked to science, engineering and technology, conceptually, educationally and politically, we had expected math education and science education majors to resemble each other.

We were concerned about general elementary education majors and their teaching of science, as most do in most states. American individual states, which set most local education policy and curricula, seem curiously relaxed about the number or kind of science courses they require for primary school teacher certification. Because elementary school science resides in a curriculum crammed with many other subjects, without an impetus such as a state exam, primary school teachers may postpone or gloss over science content. Elementary school teachers' relatively low

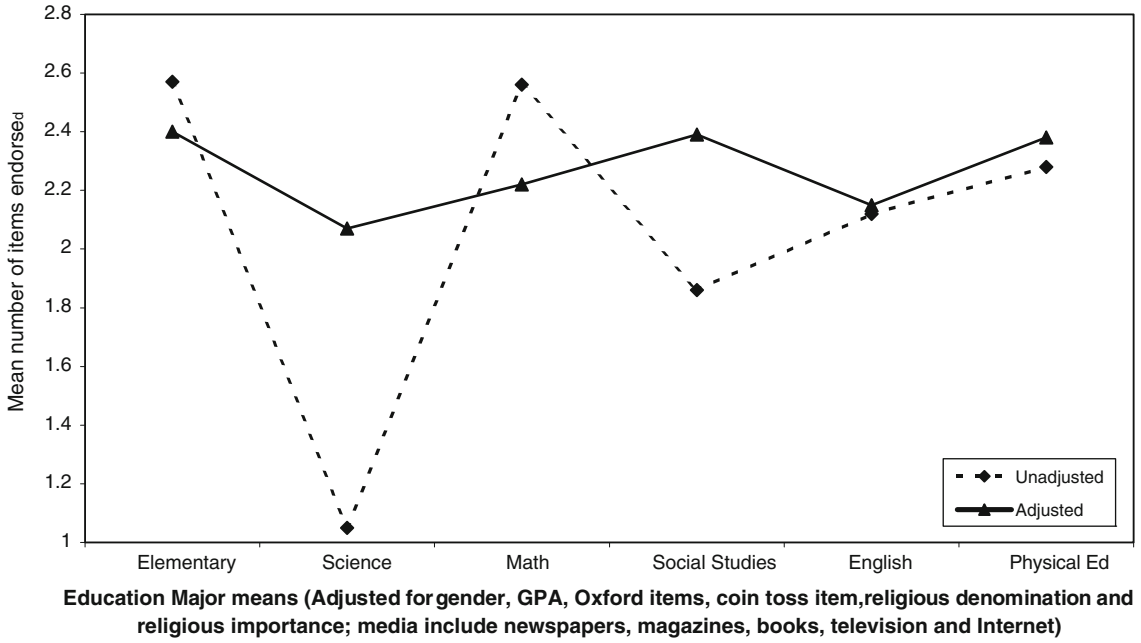

Fig. 1 Unadjusted and adjusted educational major effects on *Biblical* creation support

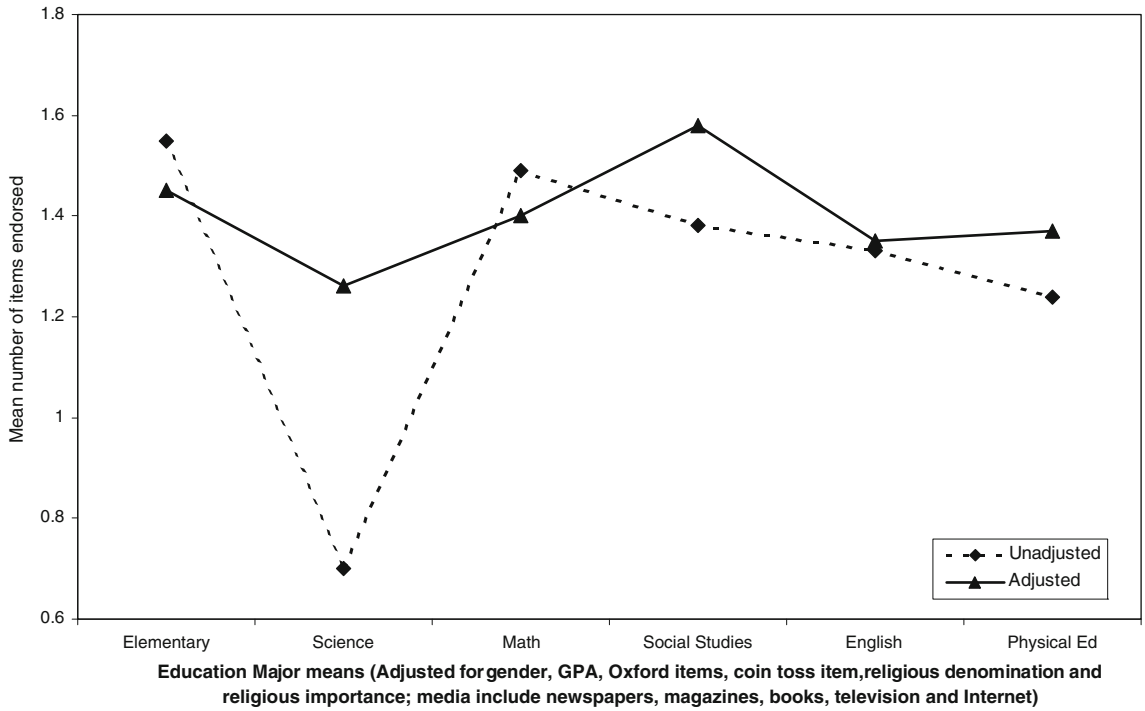

Fig. 2 Unadjusted and adjusted educational major effects on intelligent design support

exposure to traditional college science, their keenness about "hands-on" activities, and their reported delight in students' enthusiasm for such activities, combined with our findings, leads us to suspect that when science *is* sandwiched into the curriculum it may be reduced to museum-type demonstrations (e.g., the volcano) and snippets of *Biblical* interpretation.

The discontinuity between elementary school science and that taught in middle and high school may contribute to the disinterest in science that mushrooms among middle school students. Middle school students who are ill prepared in science lack the background to successfully scaffold new science material. If their factual content knowledge is low, they will poorly comprehend lessons

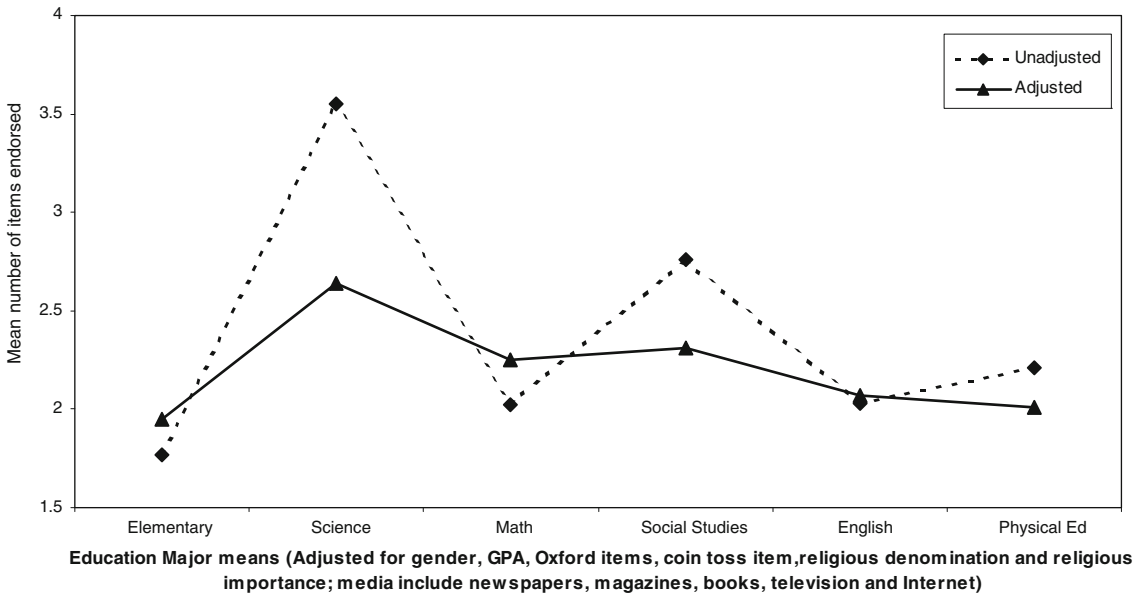

Fig. 3 Unadjusted and adjusted educational major effects on evolution support

addressing the nature of science or science inquiry processes. Students who do badly may feel frustrated, lose interest in science, and elect only minimal science requirements to graduate.

We were unsure *how much* students' education major would affect ersatz science beliefs. After all, excepting evolution, the topics we studied here are ignored in school, even though so many Americans subscribe to them. When evolution is taught, if at all possible, most high school or college faculty avoid discussing "creationism" or "ID" for scholarly, personal or political reasons. We did suspect that science education majors would explore science topics more widely in the host of media material available to them. It also seemed likely that religious denomination would affect student evolution views. Thus, we controlled religious and media variables to assess if educational major imparted any *unique or additional* resistance to pseudoscience belief.

Some of our results were startling. Science education majors rejected "creationism" or ID and supported evolution. They correctly knew the most basic science facts. Science education majors watched TV news or science programs more often, and most often read science magazines. Their knowledge and media exposure were why we were astounded that their pseudoscience rejection was limited to forms of "creationism" and failed to generalize to other topics, e.g., magic. On the other hand, elementary education majors most often supported *Biblical* creation and rejected evolution.

However, future teachers differed on several other characteristics besides their field of specialization or basic science knowledge. Elementary or math education students most often reported a fundamentalist Christian religious affiliation and both majors rated religious importance more highly than other education students. A third of science education majors said they were atheists, agnostic, or had no religious affiliation at all. When we controlled religious and media differences across education majors, major field had a relatively weak net effect on creation and evolution beliefs. Media exposure, and especially religious denomination and importance, dominated the results.

These findings denote a delicate situation for teacher educators. It is not so much that elementary—or math—future teachers were especially ignorant about science; they were not. Rather, it appears it was their religious beliefs and media habits (both majors seemed to avoid science media) that related to their beliefs about human origins. Given that religion—or media use outside of class—are deeply personal choices, faculty are understandably reluctant to address them, and would have difficulty changing such preferences even if faculty were brave or foolhardy enough to try (e.g., see Gustafson and Rowell 1995). It is one thing to explore the Schwartz cultural values domains (e.g., Akerson et al. 2008); it is quite another to dive into religion or what students access on the Internet. Our findings imply some forms of pseudoscience support are thus entrenched, necessitating more than a few extra hours in the college classroom to dispel (although elementary education majors do need more rigorous science training and a second methods course could help). Perhaps required readings (e.g., on theistic evolution) in a science education methods course could *gently* tackle both sets of preferences.

We were surprised at how little math and science education majors resembled each other. Science future teachers

resembled social studies education majors more than math education students. Indeed, the closest resemblance to math education majors was future elementary educators. Considering the emphasis on "STEM" education and occupations (e.g., Jones et al. 2003), we expected greater similarities, although, *given the relatively small sample sizes*, our comments should be tempered with caution.

Despite the national American "STEM" emphasis, we wonder how similar math and science educators really are. Upon reflection, we see different patterns of thinking in these two fields (e.g., contrast proof in mathematical theorems with how "proof" is used in science). Although math is considered a prerequisite to studying many advanced science subjects, the fields themselves or their occupants may not be comparable.

On the other hand, science and social studies education majors resembled each other in many areas. Their media choices overlapped and students in both majors were less conventionally religious than our "average" education major. They rejected young Earth creation and supported evolution. Perhaps this comparability occurred because current social science textbooks typically include at least one research methods chapter. The social science major at many colleges requires methods and statistics courses to graduate. At the least, the results suggest to us that it may be fruitful to include the social sciences in STEM concentrations.

The data indicate that creationism attitudes differ from other pseudoscience topics among future teachers. In an earlier article Losh and Nzekwe (2011), we reported that although evolution and creation items negatively correlated among preservice teachers, and moderate intercorrelations existed among the Creatures, Magic or "aliens" measures, these two sets of indices poorly correlated with each other. These correlation patterns suggest that despite "recent" emphases on teaching science inquiry, students are limited in how well they assess fantastic claims. Science knowledge only related to items about *Biblical* creation or evolution, suggesting that students' science knowledge was compartmentalized by topic. We need more items that assess understanding science inquiry to make more definitive generations in that area.

Even well educated professionals sometimes have trouble distinguishing "real" from "pseudo" science nuances outside of their own fields. Scientific or technological advances may *contribute* to pseudoscience belief because more specialized knowledge of a particular topic (e.g., stem cell research) is required to distinguish feasibility from fantasy. Worse yet, science educators compete with supposed TV "science channels" or popular science magazines, which often uncritically accept pseudoscience assertions. It's tough to be a science educator in today's media heavy society. Our results suggest that it's almost as difficult to train elementary school science educators, especially when they have had little exposure to basic college science.

Our results do suggest some directions for science *methods* classes, especially those designed for future elementary educators.[14] Cognitive research implies that pseudoscience beliefs can help teach science methods and critical thinking. For example, asking students to critically examine the pro and con evidence about ghosts in pairs (see Rosenthal 1993 and below) can illustrate science inquiry, scientific methods, the credibility of different kinds of evidence—and thus the nature of science. Indeed, based on their probable low exposure to college science, elementary education majors are likely to be more familiar with the idea of ghosts than they are with much of biology or chemistry. Science rules of evidence can be used to tackle phenomena such as astrology.

Our findings about student media preferences can also suggest recommendations not only for K-6 science teachers (brief surveys of younger children can help ascertain their viewing and reading preferences) to use to combat pseudoscience but also for teacher educators. Video clips from "science channels", articles from mass market "science" magazines, or links to Internet sites can provide a starting point for discussion.

For example, clips from the *Mythbusters* program, a series on the Discovery channel or expository use of the *Ghosthunters* program on the SyFy channel[15] could be analyzed in an elementary education science methods class. Some advantages of *Mythbusters* include their clear orientation toward debunking pseudoscience and diverse topical coverage. Following NOS expositions, the instructor can ask students how the "investigators" drew their conclusions. What methodologies did they use to collect their data? What *kind* of evidence did they obtain? Were only positive or confirmatory findings reported? How do "mainstream" science topics, methodologies, evidence and conclusions differ from those in popular media such as *Ghosthunters*?

Teacher educators understandably may feel squeamish or that addressing topics such as ghosts in elementary education science methods classes legitimizes them. Almost certainly, although they realize their students have problems defining NOS, they still fail to recognize how much cognitive confusion exists among students over how to assess fantastic claims. It is especially important for elementary education science methods courses, since these future teachers, in a best-case scenario, will create the continuities between science education in the early grades

[14] This is besides recommending *at least one* traditional science course, e.g., biology, chemistry or physics in order for education graduates to receive elementary education certification in their state.

[15] *Ghosthunters* is one example of what is often touted as "science" on American TV science channels.

and those in middle and high school. The alternative—currently the norm—delegates pseudoscience "instruction" to popular media. Teacher educators must address these costly "science alternatives" and educating preservice teachers during college training is a solid way to start.

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 Haim Eshach, Raymond Eve, Ken Feder, Ryan Wilke, Alice Robbin, Martin Bauer, Bob Bell, Jaqui Falkenheim, and Nick Allum for insightful suggestions. The responsibility for errors, of course, rests with us.

References

Abell SK, Smith DC (1994) What is science? Preservice elementary teachers' conceptions of the nature of science. Int J Sci Educ 16(4):475–487

Akerson VL, Buzzelli CA, Donnelly LA (2008) Early childhood teachers' views of nature of science: the influence of intellectual levels, cultural values and explicit reflective teaching. J Res Sci Educ 45(6):748–770

Allum N, Sturgis P, Tabourazi D, Brunton-Smith I (2008) Science knowledge and attitudes across cultures: a meta-analysis. Public Underst Sci 17(1):35–54

Appleton K, Kindt I (1999) Why teach primary science? Influences on beginning teachers' practices. Int J Sci Educ 21(2):155–168

Bann CM, Schwerin MJ (2004) Public knowledge and attitudes scale construction: analysis of short forms. Prepared for NSF Science Resource Studies. RTI International (May). Contract No. GS-10F-0097L; RTI Project No. 8796

Bartholomaus D (2010) Jenny McCarthy Body Count www.jennymccarthybodycount.com. Accessed 6 Feb 2011

Berkman MB, Plutzer E (2010) Evolution, creationism, and the battle to control America's classrooms. Cambridge University Press, New York

Berkman MB, Pacheco JS, Plutzer E (2008) Evolution and creationism in America's classrooms: a national portrait. PLoS Biol 6(5): e124. doi:10.1371/journal.pbio.0060124. Accessed 26 Feb 2010

Bloom JW (1989) Preservice elementary teachers' conceptions of science: science, theories and evolution. Int J Sci Educ 11(4): 401–415

Carlston D (2010) Social cognition. In: Baumeister R, Finkel E (eds) Advanced social psychology: the state of the science, chapter 3. Oxford University Press, New York, pp 63–99

Davis JA, Smith TW (2009) General social surveys, 1972–2008. National Opinion Research Center and Storrs, Chicago, The Roper Center for Public Opinion Research, University of Connecticut (distributor), CT

Erikson RS, Tedin KL (2011) American public opinion: its origins, content and impact, 8th edn. Pearson Longman, New York

Eve RA, Dunn D (1990) Psychic powers, astrology and creationism in the classroom? Evidence of pseudoscientific beliefs among high school biology and life science teachers. Am Biol Teach 52(1):10–21

Feder KL (1984) Irrationality and popular archaeology. Am Antiq 49(3):525–541

Feder KL (1985/6) The challenges of pseudoscience. J Coll Sci Teach 15(3):180–186

Fiske ST, Taylor SE (1991) Social cognition, 2nd edn. McGraw-Hill, New York

Gerbner G (1987) Science on television: how it affects public conceptions. Issues Sci Technol 3(Spring):109–115

Gustafson BF, Rowell PM (1995) Elementary preservice teachers: constructing conceptions about learning science, teaching science and the nature of science. Int J Sci Educ 17(5):589–605

Jones I, Lake VE, Dagli U (2003) Integrating mathematics and science in undergraduate early childhood teacher education programs. J Early Child Teach Educ 24(1):3–8

Jones I, Lake VE, Dagli U (2005) Integration of science and mathematics methods and preservice teachers' understanding of constructivism. J Early Child Teach Educ 25(2):165–172

Losh SC (2011) Age, generational, and educational effects on American adult public understanding of science. In: Bauer MW, Shukla R, Allum N (eds) The culture of science-how does the public relate to science across the globe?. Routledge, NY

Losh SC, Nzekwe B (2011, in press) Creatures in the classroom: preservice teacher beliefs about fantastic beasts, magic, extra-terrestrials, evolution and creationism. Sci Edu

Losh SC, Tavani CM, Njoroge R, Wilke R, McAuley M (2003) What does education *really* do? Educational dimensions and pseudo-science support in the American general public, 1979–2001. Skeptical Inq 27(5):30–35

Moore R, Cotner S (2009) Educational malpractice: the impact of including Creationism in high school biology classes. Evol Educ Outreach 2:95–100

Morgan M, Shanahan J (1999) Television and its viewers: cultivation theory and research. Cambridge University Press, London

National Center for Science Education (2011) Antievolution legislation in Oklahoma. January 19. http://ncse.com/news/2011/01/antievolution-legislation-oklahoma-006438. Accessed 7 Feb 2011

National Science Board (2010) Science and engineering indicators 2010. National Science Foundation (NSB-10-01). Chapter 7. Public Attitudes and Understanding, Arlington

Pew Forum on Religion and Public Life (Pew 2009b). Many Americans mix multiple faiths: eastern, New Age beliefs widespread. Pew Research Center, Washington. http://pewforum.org/docs/?DocID=490#1 Accessed 21 Apr 2010

Pew Research Center for the People and the Press (Pew 2009a) A survey conducted in collaboration with the American Association for the Advancement of Science. http://people-press.org/report/528/ Accessed 10 July 2009

Rosenberg M (1968) The logic of survey analysis. Basic Books, New York

Rosenthal D (1993) A learning cycle approach to dealing with pseudoscience beliefs of prospective elementary teachers. J Sci Teacher Educ 4(2):33–36

Schneider B, Carnoy M, Kilpatrick J, Schmidt WH, Shavelson RJ (2007) Estimating causal effects using experimental and observational designs: A Think Tank White Paper. American Educational Research Association, Washington

Singer E, Endreny PM (1993) Reporting on risk: how the mass media portray accidents, diseases, disasters, and other hazards. Russell Sage Foundation, New York

Skamp K, Mueller A (2001) A longitudinal study of the influences of primary and secondary school, university and practicum on student teachers' images of effective primary science practice. Int J Sci Educ 23(3):227–245

Spanos NP, Cross P, Dickson K, DuBreuil SC (1993) Close encounters: an examination of UFO experiences. J Abnorm Psychol 102(4):624–632

Stollznow K (2009) Paranormal wall street. *ESkeptic*, Wednesday September 30. http://www.skeptic.com/eskeptic/09-09-30/ Retrieved 6 Sept 2010

Willingham DT (2007) Critical thinking: why is it so hard to teach? Am Educ 31(2):8–19