

The Foundations: How Education Major Influences Basic Science Knowledge and Pseudoscience Beliefs

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Abstract— Although many pseudoscience beliefs are popular, most American research examines creation/evolution among liberal arts majors, general public adults, or, infrequently, secondary school science teachers, thus truncating the *range* and the *populations* it studies. *It is especially critical to study future elementary educators* because of the science interest “watershed” (particularly among girls) during middle school. Because teachers have considerable influence on youth, we studied very basic science knowledge and beliefs about extraterrestrials, magic, *Biblical* creation, and evolution among 540 female and 123 male education majors. Compared with other education students, future elementary educators rejected evolution, supported some form of “creationism”, were comparable on other pseudoscience topics, and accessed less science media. Religious and media variables were important predictors of creation/evolution beliefs. Implications are discussed for how faculty may address pseudoscience beliefs among education majors.

Index Terms— Basic science knowledge, pseudoscience beliefs, education majors, elementary school science educators

I. 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 [1].

Most pseudoscience research examines the creation/evolution “controversy”¹ among liberal arts majors, general public adults, or, more rarely, 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, perhaps including a plea for better science education. Yet “alternative medicine” or capricious opposition to modern medicine can literally kill². Expensive psychics encourage fatalism [3]. Tales of extraterrestrial abduction substitute fantasy for natural explanations.

This is an especially important era in which to study such topics. Since the 2005 Dover, Pennsylvania legal decision, which rejected teaching “Intelligent Design” in public school science classes, 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 chambers in Oklahoma introduced legislation to mandate teaching “challenges” to evolution, climate change, stem cell

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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 [2], see: <http://www.jennymccarthybodycount.com> accessed February 6, 2011.

research and cloning in public schools [4]. A proposed 2011 theme park in Kentucky, poised to receive taxpayer rebates, asserts that Noah's Ark rescued dinosaurs and unicorns.

Although teachers reach far more people than the average adult in national science literacy surveys, scholars also neglect studying pseudoscience beliefs among *educators in different disciplines*. Because most American adults lack even an Associate of Arts college degree, K-12 teachers disproportionately affect civic science literacy [5]. General elementary school teachers in most U.S. states teach science as well as reading and mathematics, thus establishing the foundation for more advanced science instruction. However, compared with middle or high school science teachers, they are poorly prepared, making it especially important to study elementary educators.

Thus, *this study compares basic science knowledge and diverse pseudoscience beliefs among education majors in different disciplines*. We examined beliefs, e.g., magic or *Biblical* creation, among several hundred majors, 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 influences on student teachers' pseudoscience beliefs?
- How do media choices among student teachers relate to pseudoscience beliefs?

A. American pseudoscience support

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 such stereotypes (e.g., [6]). These beliefs are simply too prevalent in the American general public (e.g., [7]) to be the bailiwick of an "unbalanced" few.

For example, nearly *two-thirds* of adults in a 2009 [8] national Pew telephone 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 Pew 2009 [9] survey for the American Association for the Advancement of Science, 87% of scientists but only 32% of the general public supported evolution.

Teachers are far from immune: Eve and Dunn [10] found notable support for contacting the dead or psychics (each 29%) in a National Science Teachers Association sample of *life science and biology high school teachers*. One fourth endorsed *Biblical* creation and 45% agreed God created Adam and Eve as the first human beings. Twenty years later, one quarter of the nearly 1000 U.S. secondary biology teachers Berkman and Plutzer studied [11],[12] actually *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 students taught "creationism" in high school resist learning about evolution in college [13].

Given the "watershed" in science interest occurring among many middle and high school students, it seems imperative to further study elementary educators who nearly all teach science. For example, 39% of Bloom's [14] Canadian student teachers described themselves as "creationists" and these future elementary educators seemed to have a anthropocentric view of evolution that culminated in human beings.

B. Elementary Educators and Science

We have less research on elementary school teachers than on middle or high school educators, but enough exists to warrant some tentative conclusions. U.S. elementary teachers face a teaching schedule crammed with reading, math, history, and electives—and most must also teach science. As students, many were uneasy about their own science education; they lack confidence; and are confused about the nature of science [15],[14],[16]. For example, when asked about NOS future elementary educators most often mentioned "discovery" of a set of fixed and "underlying truths" (often acquired through "hands on activities"; e.g., [17]). Hands on activities are viewed as indicators of "good science teaching" [16] while concepts such as "theories", are less well known and muddled³ [17],[18],[14],[19],[16]. Under such circumstances, teaching

³ A second science elementary education methods course or addressing the nature of science in a second [non-science] education course may help [18,20].

science can fall to the end of the elementary school curriculum.

In part, low science exposure fosters these 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 and need not be “traditional” offerings such as biology [14],[16] (for United Kingdom countries). At many colleges and universities, one can meet liberal arts science requirements 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.⁴

Unfortunately, as one cognitive researcher explains [21], teaching critical thinking, which comprises part of NOS instruction, and forms part of science methods 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 educator 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.

C. Sources of pseudoscience belief

Cognitive. Our background is in social psychology heuristics (e.g., [22],[23]). We believe pseudoscience can appeal because individuals misunderstand the nature of science and many pseudoscience beliefs seem plausibly related to current science developments (e.g., “stem cells” in new cosmetic creams.) Some “beyond the fringe” science [24] can resemble “fringe” or even the “frontiers” of science. Current and future educators can be confused about NOS and be unable to separate a scientific theory from authoritative (e.g., *Biblical*) or other assertions (e.g., [11],[10]).

Education and religiosity. Although public opinion surveys repeatedly find that more educated adults support evolution and reject creationism or Intelligent Design (ID), formal education relates inconsistently to other pseudoscience beliefs. Those who are more familiar with basic science factual material, who tend to be more educated, more often reject *traditional* pseudoscience (e.g., *Biblical* creation or astrology; [2],[5]). On the other hand, endorsing some forms of alternative medicine, clairvoyance, or extraterrestrial visits is either unrelated to education—or *rises* with formal schooling [25, ch. 7],[8],[9].

The same sources indicate that religiosity plays a critical role in evolution beliefs. *Biblical* literalists and adults defining themselves as very religious often reject evolution and endorse creation [8]. Interestingly, these same adults also *less* often support *other pseudoscience*, such as reincarnation, astrology, contacting the dead, or ghosts [8],[9]. We include two basic measures of religion in our analyses.

Media. Perhaps pseudoscience popularity should be expected, given its extensive media coverage. Science and pseudoscience are popular topics among U.S. adults [25, ch.7]. “Science channels” on cable television include programs on “ghost hunters”; popular science magazines sometimes endorse “natural cures” or speculate about UFO landings. Because Americans voraciously consume media, studying how such beliefs relate to media exposure may suggest ideas to 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 [26]. Nevertheless, *cultivation theory* [27],[28] 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 [29].

II. 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) at a large Southeastern state university. Nearly half (49%) were elementary education majors; most of those 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

⁴ Among our participants for this study, 19 percent agreed, humans and dinosaurs lived at the same time.

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 ($\chi^2_{(5)} = 184.83, p < .001$). 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 religion⁵ [10], [30],[31]. Ten 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 samples of U.S. adults since 1988. Also employed in international surveys such as the *Eurobarometer*, they have been called the “Oxford items”; items address facts taught in late primary school and reviewed in middle school [32],[33].

Besides their brevity, we use these factual items because the NSF has extensively studied their intercorrelations and psychometric properties [34]⁶. The index built from the Oxford items has a history of predicting *traditional* pseudoscience beliefs in U.S. general public samples of adults [5].

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.⁷ Each item was measured through a 4-point Likert scale. 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 1.⁸

TABLE I
QUESTIONNAIRE ITEMS FOR STUDY INDICES⁹

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.¹⁰

⁵ The questionnaire is available upon request from slosh@fsu.edu, eve@uta.edu or feder@ccsu.edu.

⁶ This report is available by email from the first author (slosh@fsu.edu).

⁷ 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).

⁸ For correlations among these indices, see [35], Table 6.

⁹ 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

¹⁰ Some “Intelligent Design” proponents will accept an “old earth”; others will not. The key here was the phrase “intelligent designer”.

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.

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.]

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 Christian¹¹ (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 taxonomies on denominations [7].

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

III. RESULTS

We employ percentages and analyses of variance (ANOVA) or covariance (ANCOVA) in data analysis.¹² Following [36] or [37], 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 MCA results compare unadjusted and adjusted (controlled) means 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.

¹¹ There were no participants who identified as orthodox Jews or Muslims of any kind.

¹² We also reference bivariate correlation coefficients published earlier [35].

Table 2 presents agreement, disagreement and “other” (mostly “uncertain”) student teacher percentages on the evolution, creation, Intelligent Design, creatures, magic, and extraterrestrials items. We found the levels of uncertainty striking as these juniors and seniors “awaited more evidence” on topics, which, despite their longevity, have no accrued scientific support, e.g., astrology. One-fourth of these future teachers were unsure whether “Bigfoot” was “real”. Nearly one-third weren’t sure whether the Loch Ness monster was imaginary. When we added uncertainty to agreement, many responses approached half the sample, e.g., 49% agreed or were undecided whether “magic really exists” and 53% either agreed or were undecided that the U.S. government was “hiding information...that UFOs are alien spacecraft.” In contrast, uncertainty responses on basic science facts in the Oxford items did not exceed 10%.¹³

TABLE 2
PRESERVICE EDUCATORS’ DISTRIBUTION OF PSEUDOSCIENCE ITEMS (MINIMUM N = 639)

Evolution Support				
Survey Item	Agree	Disagree	Other	Total
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%
Mean 2.09 s = 1.54 n = 658				
(Young Earth) Creation Support				
Survey Item	Agree	Disagree	Other	Total
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%
Mean 2.29 s = 1.74 n = 660				
Intelligent Design Support				
Survey Item	Agree	Disagree	Other	Total
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%
Mean 1.42 s = 1.06 n = 662				
Creatures				
Survey Item	Agree	Disagree	Other	Total
No Loch Ness Monster	58%	12	30	100%
Bigfoot is real	8%	67	25	100%
Mean 0.20 s = 0.47 n = 656				
Magic				
Survey Item	Agree	Disagree	Other	Total
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%
Mean 1.03 s = 1.25 n = 658				
Extraterrestrials				
Survey Item	Agree	Disagree	Other	Total
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%
Mean 0.43 s = 0.85 n = 659				

¹³ 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 changes neither the overall results nor conclusions.

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 GPA by education major. These *unadjusted* means on pseudoscience indices form the initial scores for the MCA analysis later presented in figures 1 through 3.

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

Future educators differed on other characteristics besides GPA, science knowledge or pseudoscience support. 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 also 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 ($F_{5,636} = 2.30, p = .04$).

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 ¹⁴							
(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 <i>n</i>	315	23	103	80	57	46	624

¹⁴ 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 ¹⁵	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 frequency¹⁶							
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
<i>Biblical</i> 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 <i>n</i>	315	21	101	80	55	46	623

¹⁵ Probability levels are all from a one-way Analysis of Variance *p < .05 **p < .01 ***p < .001

¹⁶ Response alternatives were: 1 = Never; 2 = Rarely; 3 = Sometimes; 4 = Often.

We focus on background and media characteristics, because, as Table 5 shows, religious and media variables were the most strongly related to pseudoscience beliefs. With these variables controlled education major effects diminish considerably. Although we do *not* assign causal priorities to media use because beliefs about “creationism”, evolution or magic reciprocally relate to 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^2 s are shown at the bottom of each index column. Background, knowledge, religiosity and media variables were the strongest predictors of beliefs about human origins, suggestive in predicting magical beliefs and not useful to predict beliefs about fantastic beasts or space aliens.

With other variables controlled, education major had a minor effect on creationism or evolution beliefs, 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 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; 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 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 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 unreligious. 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 *less* often. They did, however, more often read books about *Biblical* creation. We revisit these issues in our discussion because 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 probably be helpful).

Finally, in Figures 1, 2 and 3, we present the unadjusted and adjusted mean scores by education major on support for Biblical creation, ID or evolution,¹ 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.*

¹ Because education major did not influence beliefs about creatures, magic or extraterrestrials we do not present MCA graphs for these three indices.

TABLE 5
ANALYSIS OF COVARIANCE STANDARDIZED PARTIAL MULTIPLE CLASSIFICATION ANALYSIS (MCA) COEFFICIENTS ON PSEUDOSCIENCE INDICES¹

Dependent (Criterion) Variable→ Predictor	Biblical Creation	Intelligent Design	Support Evolution	Creatures	Magic	Extraterrestrials
Education disciplinary major ²	.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
<i>n</i>	575	576	573	571	573	573
R ² analogue ³ 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

¹ Coefficients are standardized betas from Multiple Classification Analysis for the factors or standardized b coefficients for the covariates.

² Standardized betas for education disciplinary major or religious denomination are for the *entire set* of variable categories.

³ From Multiple Classification Analysis, analogous to η^2 in analysis of covariance.

Figure 1: Unadjusted and Adjusted Educational Major Effects on *Biblical* Creation Support

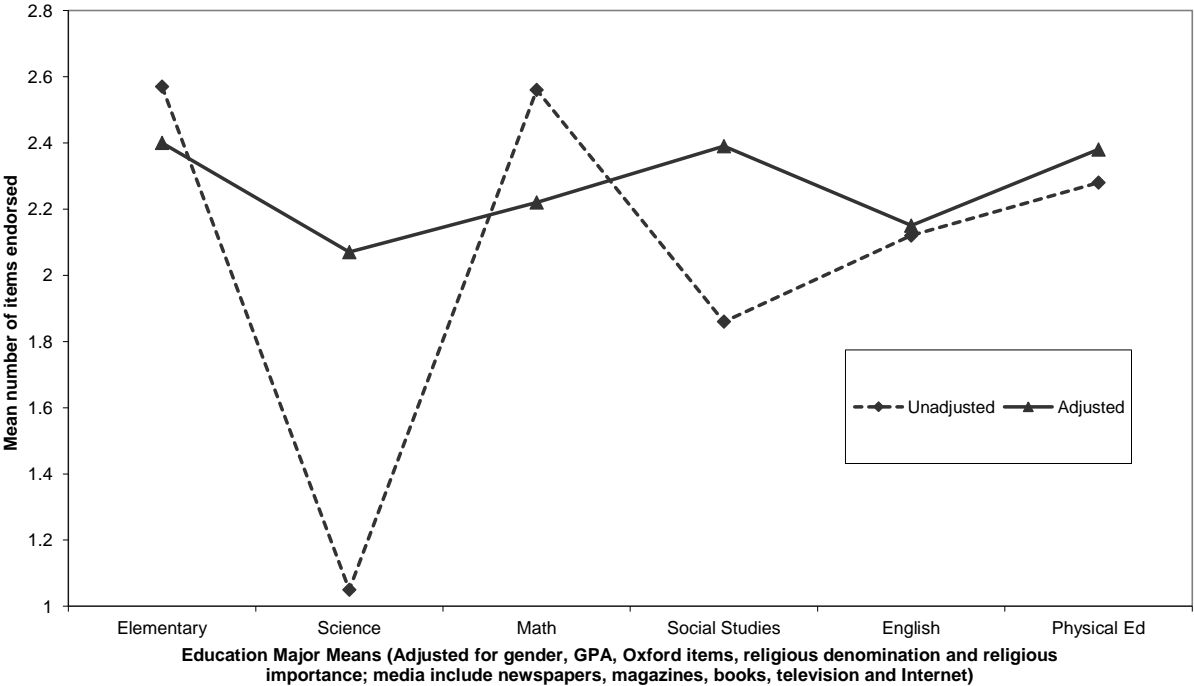


Figure 2: Unadjusted and Adjusted Educational Major Effects on Intelligent Design Support

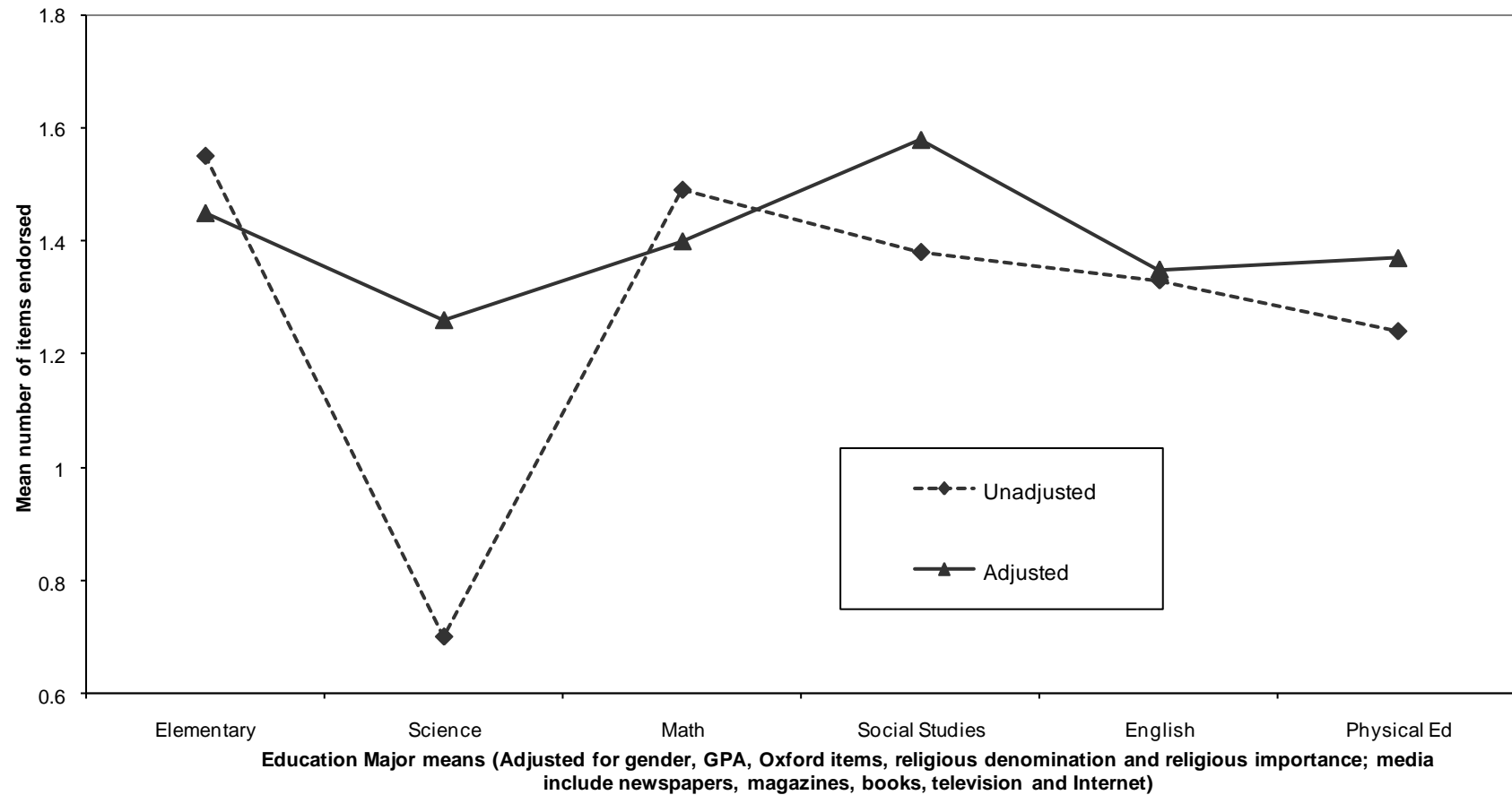
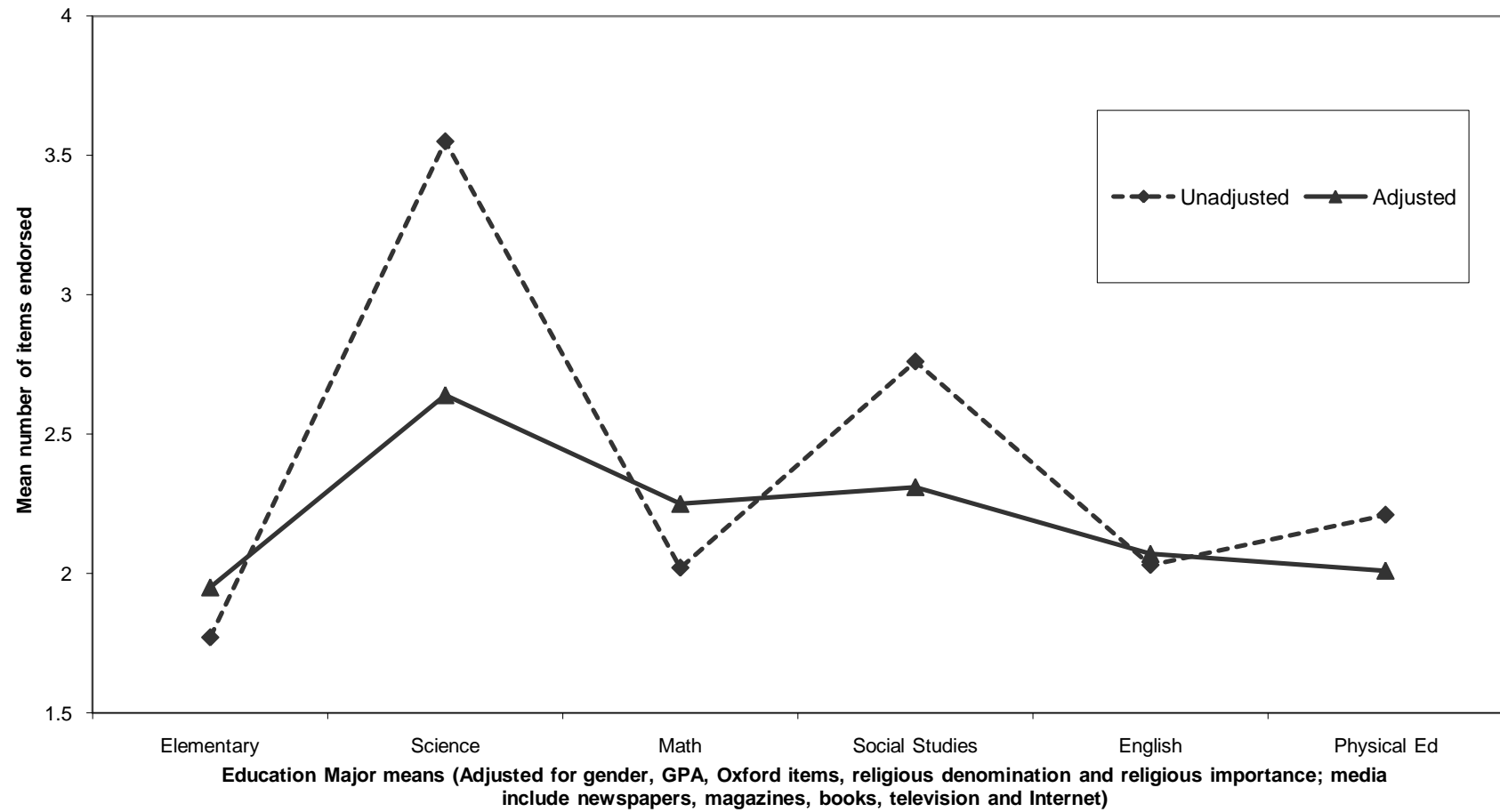


Figure 3: Unadjusted and Adjusted Educational Major Effects on Evolution Support



IV. DISCUSSION, CONCLUSIONS, IMPLICATIONS

This study examined how student 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 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 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 by more specialized teachers in middle and high school may contribute to the disinterest in science that mushrooms among middle school students. Middle school students who were 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 addressing the nature of science or science inquiry processes. Students who do badly may feel frustrated, lose interest in science, and elect only the 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 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. As we expected, 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 wider 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 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, agnostics, 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 imply a delicate situation for teacher educators. It is not so much that elementary—or math—education majors were especially ignorant about science; they were not. Rather, 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 [20]). It is one thing to explore the Schwartz cultural values domains [18]; it is quite another to dive into religion or what students access on the Internet. Our findings suggest that 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). Perhaps required readings (e.g., on theistic evolution) in a science education methods course could *gently* tackle both sets of preferences.

We were also surprised at how little math and science education majors resembled one other. Science future teachers resembled social studies education majors more than they did math education students. Indeed, the closest resemblance to math education majors was future elementary educators. Considering the current emphasis on "STEM" education and occupations [39], 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, suggesting this interdisciplinary “marriage” may quickly develop fissures as math and science educators interact more often.

On the other hand, science and social studies education majors resembled each other in many ways. Their media choices overlapped and students choosing 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. Earlier [35], 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 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 would like more items that assess understanding science inquiry to make more definitive generations.

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 so-called 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 (besides recommending *at least one* traditional science course, e.g., biology, in order for graduates to receive elementary education certification.) Cognitive research implies that pseudoscience can help teach science methods and critical thinking. For example, asking students to critically examine the evidence pro and con about ghosts in pairs [24] can illustrate science inquiry, science methods, the credibility of different kinds of evidence—and thus NOS. 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 also suggest recommendations not only for K-6 science teachers (brief surveys of younger children can help ascertain their media 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* series on the Discovery channel or expository use of the *Ghosthunters* program on the SyFy channel (one example of what is often touted as “science” on American science TV) 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 were used 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 an 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 methods courses, since these future teachers, in a best-case scenario, will create the continuities between science education in the early grades 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 future teachers during college training is a solid way to start.

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