

Psychic Powers, Astrology & Creationism in the Classroom? Evidence of Pseudoscientific Beliefs Among High School Biology & Life Science Teachers

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Abstract:

Many authors and researchers have noted the popularity of pseudoscientific beliefs in the United States.^{1,2} Although pseudoscience is not a new phenomenon (it has been around at least as long as science itself [Trefil 1978]), some suggest that pseudoscientific beliefs have become even more widespread in recent decades.³ The last three decades have also seen a decline in scientific literacy in the general public (Hively 1988). Unless the simultaneity of these two trends is purely coincidental-which seems highly unlikely-it may well be that understanding the mechanisms behind the origin and transmission of pseudoscientific beliefs will shed some light on the decline in scientific literacy.

It is scarcely necessary to argue that knowledge and understanding of science has become more and more vital in this increasingly complex, high technology world. A much wider cross-section of the population is today asked to decide on matters involving issues with a substantial high technology component (e.g., SDI, space and environmental programs). To the extent that the promulgation of pseudoscientific beliefs is interfering with this knowledge and understanding, it must be addressed if we are to reverse the rising tide of scientific illiteracy. This paper examines one important potential source of pseudoscientific belief in the population-the extent to which those given the responsibility of transmitting knowledge of science to our high school students actually hold pseudoscientific beliefs themselves.

The first section of the analysis presents evidence for the prevalence of pseudoscientific belief among the general public. Previously suggested sources for pseudoscientific beliefs are explored in the second section. We then focus in detail on one potential source of pseudoscientific belief-science teachers. The extent and specific types of pseudoscientific belief held by a sample of high school life science and biology teachers are examined, as well as the demographic and social correlates of such beliefs. Finally, the implications of high school science teachers' pseudoscientific beliefs for science education are discussed.

Keywords: Pseudoscientific beliefs | Education

Article:

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Pseudoscientific Belief Levels in the Population

A diverse array of pseudoscientific beliefs are held by significant proportions of the U.S. population. For example, in a 1978 Gallup poll, 29 percent of those sampled said they believed in the validity of astrology, 39 percent believed in devils and 11 percent believed ghosts actually exist. In 1983, another Gallup poll found that 23 percent of a national sample asserted a belief in reincarnation, and 24 percent believed it possible to communicate with the dead. Another nationally representative poll conducted in 1987 revealed that 39 percent of the sample viewed astrology as scientific and 7 percent sometimes changed their plans after reading their horoscope (Miller 1987).⁴ In the same study, 46 percent of the sample indicated that they did not believe in human evolution by disagreeing with the statement, "Human beings as we know them today developed from earlier species of animals." Forty percent also believed that "Rocket launchings and other space activities have caused changes in our weather," and 43 percent believed that "some of the unidentified flying objects reported are really space vehicles from other civilizations" (Miller 1987).

A 1978 Gallup poll of public opinion also found that 38 percent of a representative sample of the public believed that the Bible is the actual word of God. In a similar Gallup poll taken in 1982, it was found that 44 percent of the sample agreed that "God created man pretty much in his present form within the last 10,000 years."

These high levels of pseudoscientific beliefs are found not only among random samples of the public, but also among the more educated segments of the population. A recent study of pseudoscientific beliefs among a sample of about 1000 college students at four regionally diverse institutions of higher education found that the students surveyed did not differ markedly from the general population (Harrold & Eve 1987). The researchers administered a standardized research instrument to students on two campuses in California, one in Connecticut and one in Texas. The use of a standardized survey made it possible to compare pseudoscientific belief levels of students in ways that can be assumed to generally reflect regional differences. When the students were asked if "God created man pretty much in his present form within the past 10,000 years or so," 28 percent of the Texas group and 19 percent of both the other groups agreed either "strongly" or "somewhat." Another 23 percent to 31 percent said they "didn't know." More than half of all the four geographically diverse groups of students also felt that special creationism should be taught in the public schools. Some of the most discouraging results emerged when the researchers asked the students to agree or disagree with the statement "Men and dinosaurs lived at the same time, as is shown by finds of their footprints together." In not one of the three samples did even half the students reject this claim -- and at least 28 percent of each group specifically accepted it.

The high levels of pseudoscientific belief documented in this study of college students were not confined to the area of religious doctrine. Many other "types" of pseudoscientific belief also yielded surprising findings. For example, when asked whether "It is possible to communicate with the dead," 40 percent replied in the affirmative. Similarly, 42 percent agreed that "America was visited by Europeans long before Columbus or the Vikings got here," despite a lack of evidence for such claims. In addition, more than 30 percent agreed that "The lost continent of Atlantis was the home of a great civilization" and 35 percent agreed that "Ghosts really exist" (Harrold & Eve 1987).

In another study, students and faculty in the College of Education at a state university in the western U.S. were surveyed about their beliefs in a variety of pseudoscientific notions (Bates). This survey's findings suggested that the education faculty and their students (presumably future educators) exhibited belief levels on various pseudoscientific issues that were quite similar to those of the general population. For example, 55 percent of the faculty and 60 percent of the students agreed with the statement, "Some people have extrasensory or psychic abilities that science cannot explain." Thirty percent of the faculty and 45 percent of the students agreed that people become more restless and violent when there is a full moon.

It appears, then, that our educational system is not entirely effective in passing on the knowledge or the critical thinking skills necessary to significantly reduce belief in pseudoscience. It might be tempting when confronted with the prevalence of pseudoscientific belief to assume that it is the result of a lack of formal education. However, there is a great deal of evidence that the formal education system as it is currently structured in our nation is simply not well equipped to expose such beliefs as being unsupported by science. In fact, the scant research findings which do exist on the pseudoscientific beliefs of those who staff our educational system hint at the possibility that our schools may be bolstering, rather than eradicating, pseudoscientific claims (Bates; Zimmerman 1987).

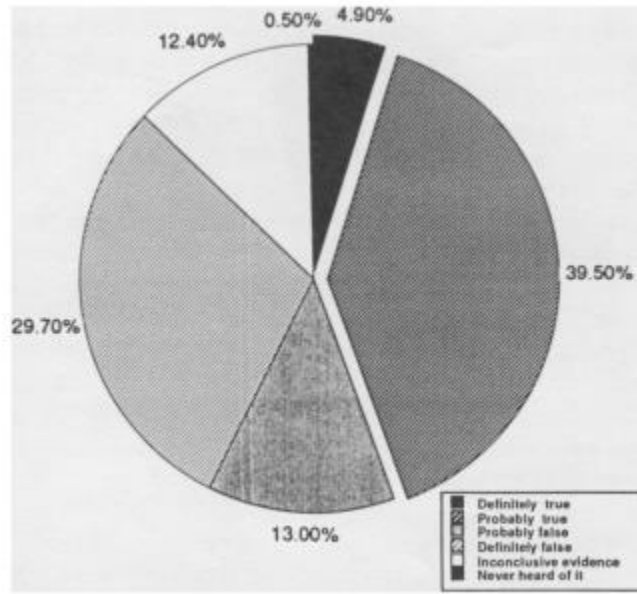


Figure 1. "The story of the Great Flood and Noah's Ark, as told in the Bible, is symbolic rather than an actual event."

Sources of Pseudoscientific Beliefs

The work of Singer and Benassi (1981) suggests that pseudoscientific beliefs have at least four different sources. The first source is common cognitive errors such as overgeneralization from personal experience or the need for cognitive economy. A second source is erroneous or sensationalistic mass media coverage of science issues. Another source is sociocultural factors having to do with the degree of social control exerted by one's religious affiliation or region of residence. A final proposed source is poor or erroneous science education. While the first three sources of pseudoscientific belief posited by Singer and Benassi have been examined in a small number of pre-existing studies, the possibility that many of the pseudoscientific ideas favored by the public could be passed on normally within the nation's science classrooms has apparently been considered so absurd as to remain largely unexamined.⁵

Certainly science education has been heavily criticized in recent years for its failure to impart a basic knowledge of science to students.⁶ But the focus of the criticism to date has been on the inability of the educational system to pass on scientific knowledge to students, rather than on the systematic "miseducating" of students that may be occurring when pseudoscientific notions are presented in the science classroom. The analysis presented below directly examines the extent to which science teachers hold pseudoscientific beliefs, providing insight into the teachers' understanding of science, as well as to the likely content of their science courses.

Teachers, School Board Members & Pseudoscientific Belief

Prior to the current study, the bulk of the scant research on educators' belief in pseudoscience has been focused on one specific area of pseudoscientific belief, specifically that of the "special creation" of humankind.⁷ A survey of high school biology teachers in the state of Ohio conducted by Zimmerman (1987) found that "at least 15 percent of the biology courses examined (i.e. those taught by the respondents), contained a creationism component that treats

the topic favorably." Nickels and Drummond (1985) surveyed teachers attending the Illinois Science Teacher's Association conference and found that 20 percent agreed that "The Bible is an authoritative and reliable source of information even with respect to such scientific issues as the age of the earth and the origin of life." Twenty-nine percent also agreed that "Much, if not all, of the fossil-bearing strata of the earth can be satisfactorily explained by the occurrence of a recent world-wide flood," and 30 percent believed that "Both creation and evolution should be taught in the science classroom because it is only fair to give equal time to alternative explanations for the same data."

In an unpublished study by Zimmerman, the author sent a questionnaire to 730 school board presidents throughout the state of Ohio and found that a majority (53 percent of those responding) indicated that "Creation science should be taught in a favorable light." While many school board presidents may be reluctant to tell teachers what they should say about their subject in the classroom, it is likely that at least in some cases the school board president's opinion does influence curriculum.

Studies such as those described above indeed suggest the possibility that high school science teachers might be an important source of pseudoscientific belief in the larger population. While these studies were conducted with regional samples, and focused on only one type of pseudoscience, the present analysis departs from this tradition by examining a wide array of pseudoscientific beliefs among a national sample of high school teachers. A review of recent reports on the state of education in the U.S. indicates that there is much concern today over whether science teachers have received adequate instruction in the philosophy and methodology of science.⁸ Because this type of training is a critical tool for distinguishing between bogus scientific beliefs and valid scientific findings, it is likely that some teachers may not have the educational foundation necessary for recognizing pseudoscientific claims.

Research Design & Sample

The sample of teachers used in this study was drawn from a data tape provided by the National Science Teachers Association in Washington, DC. The data tape contains names, addresses, subject areas and grade levels for approximately 20,000 secondary school life science and biology teachers in the United States. The information on the tape represents a large sample of teachers drawn from the National Register of Teachers, which contains the names and addresses of virtually all the science teachers in the United States. The 20,000 names were selected as every "nth" case from the National Register's total list of approximately 48,880 high school life science and biology teachers. From this large national sample, we chose a smaller random subsample of 387 teachers.⁹

The questionnaires that were mailed to the 387 teachers covered basic demographic information such as age, sex and religion; information on the respondent's preparation for a teaching career; and opinions on a wide variety of pseudoscientific beliefs.¹⁰ Other items assessed the extent to which the teacher's willingness to present pseudoscientific material in the classroom would be affected by pressures from students, parents, school administrators and other individuals. The cover letter accompanying the questionnaire indicated that the results would be confidential, but not anonymous.

One hundred and ninety questionnaires were returned, which represents a response rate of 49 percent. This response rate is fairly high for a lengthy mailed questionnaire (13 pages) which was confidential, but not anonymous, and included information on controversial issues. It is

worth mentioning that several teachers wrote us indicating they would not complete the questionnaire because they feared reprisals.

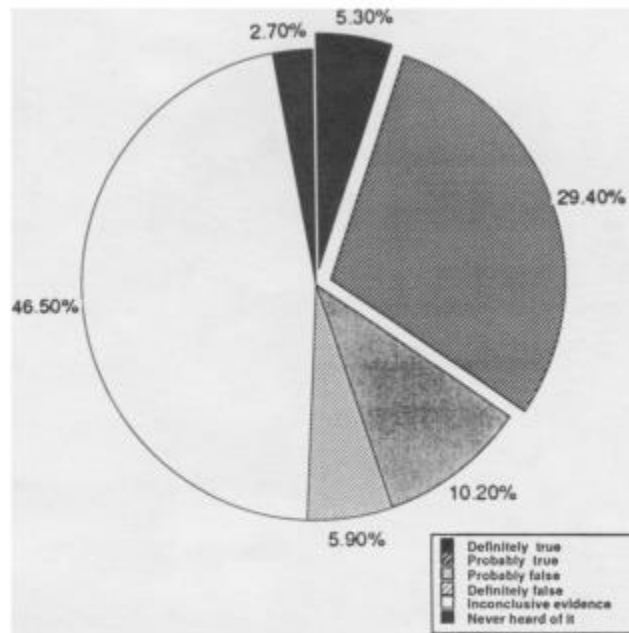


Figure 2. "Evidence of Noah's Ark has been found on Mt. Ararat in Turkey."

Findings: Teachers Do Hold Many Pseudoscientific Beliefs

The high school teachers surveyed in our study expressed belief in a number of pseudoscientific phenomena. Figures 1 through 12 provide some examples of pseudoscientific claims which were supported by the teachers in our sample.

The strongest support for pseudoscientific claims was found for the items that were related to Biblical literalism. Items involving a strict literalist interpretation of the Bible received average support levels of about 30 percent from the teachers. For example, when asked if "The story of the Great Flood and Noah's Ark, as told in the Bible, is symbolic rather than an actual event," 43 percent of the teachers thought the statement was either definitely or probably false, with another 12 percent unsure (Figure 1). Thirty-five percent of the teachers believed (either definitely or probably) that "Evidence of Noah's Ark has been found on Mt. Ararat in Turkey" (Figure 2).

A strictly literal interpretation of the account of human origins put forth in the Biblical book of Genesis was also supported by a surprisingly large sample of the biology and life science teachers. Typically those who adopt such a literalist position believe that the earth is less than 10,000 years old.¹¹ Twenty-seven percent of the teachers in our sample agreed that "The Bible is an authoritative and reliable source of information with respect to such scientific issues as the age of the earth and the origin of life" (Figure 3). In light of the above, it is not surprising to learn that 19 percent of the teachers agreed that "Dinosaurs and humans lived at the same time." Another 13 percent felt that evidence on this matter was inconclusive (Figure 4). Apparently, many of the teachers have been influenced by published reports of the "Paluxy man-tracks" found near Glen Rose, Texas—supposedly in the same rock strata as nearby dinosaur tracks.¹²

Mainstream scientists have now refuted the claim that these tracks are of human origin. Even the "creation science research institutes" have abandoned the claim that the "Paluxy mantracks" provide evidence that humans and dinosaurs co-existed.

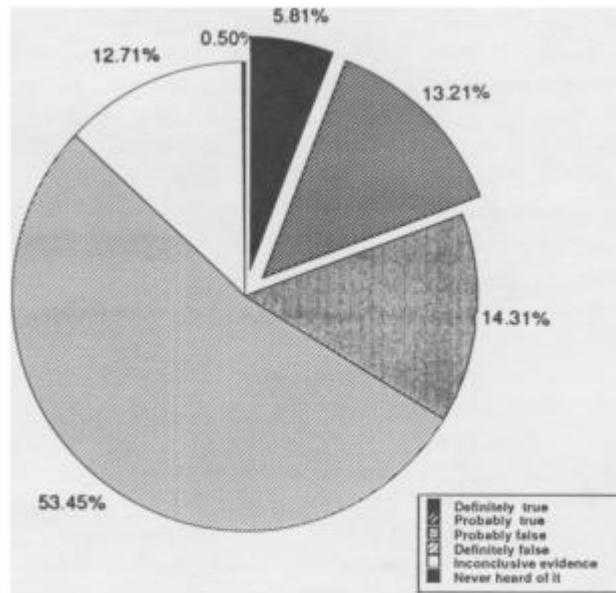


Figure 4. "Dinosaurs and humans lived at the same time."

A sizable proportion of the biology and life science teachers in our sample also expressed support for creationism. Forty-five percent agreed that "Adam and Eve were the first human beings and were created by God" (Figure 5). Twenty-five percent agreed that "God created humanity pretty much in its present form within the last 10,000 years" (Figure 6). The teachers' support for special creationism is also indicated by their agreement with statements critical of the theory of evolution. For example, 39 percent agreed that "There are sufficient problems with the theory of evolution to cast doubt on its validity" (Figure 7). Even more striking is the finding that 30 percent of the teachers would teach only creationism in their science classes if forced to choose between creationism and evolution (Figure 8).

In recent years, proponents of creationism, having lost repeated attempts to have the courts require that their doctrine be taught in science classes, have been considerably more successful when switching to a tactic which appeals to the American credo of fair play. They have begun to suggest that "equal time" should be given for the airing of their minority opinion. Many of the teachers in our sample agree. Forty-three percent agreed with the statement "Regardless of the validity of the concepts of special creationism and evolution, proponents of each should be allowed equal time to express their views in science classes in school" (Figure 9).

Although belief levels in those pseudoscientific areas related to Biblical literalism received the greatest support in our study, other types of pseudoscientific beliefs were also endorsed. The teachers' support levels for "non-Biblical" pseudoscientific beliefs typically hovered around 20 percent. For example, 29 percent felt that it is possible for the living to communicate with the dead (Figure 10). Twentynine percent agreed that people can predict future events via psychic power (Figure 11). Yet only 1 percent of the sample agreed that "Astrology is an accurate predictor of people's personalities" (Figure 12). Apparently the

endorsement of this form of pseudoscience by former first lady Nancy Reagan has done little to increase its popularity. In fact, the attention given the issue may have caused the public to become even more skeptical.

It is important to note that although surprisingly high levels of pseudoscientific belief were found in our sample of teachers, a solid majority did not express belief in the range of pseudoscientific items on the questionnaire. In fact, a few wrote reactions to questionnaire items indicating disbelief that anyone would consider the pseudoscientific issue seriously. A few others offered lengthy and rather eloquent explanations as to why the phenomena of interest were not scientific. The duality of responses from teachers in our sample suggests that while there are many qualified and even exemplary biology teachers, the number of those who did not exhibit adequate scientific reasoning skills is significant enough to justify alarm.

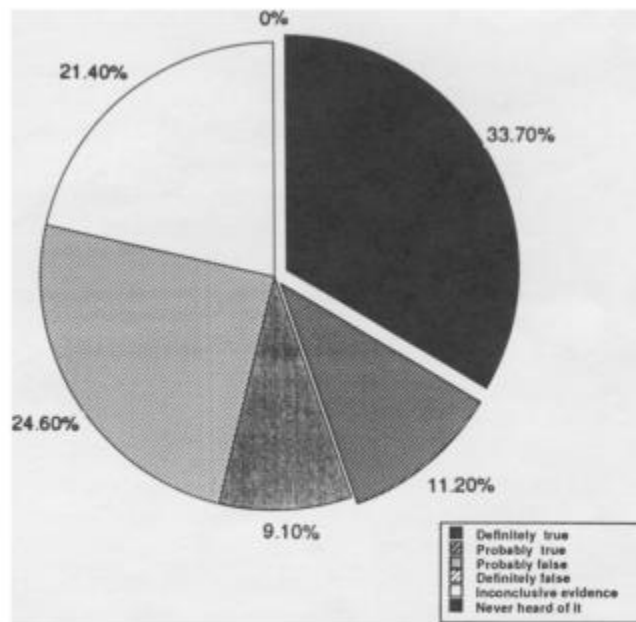


Figure 5. "Adam and Eve were the first human beings and were created by God."

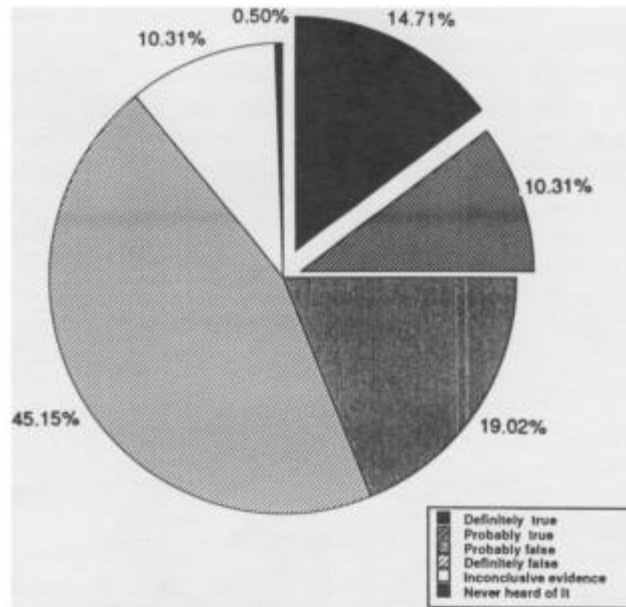


Figure 6. "God created humanity pretty much in its present form within the last 10,000 years or so."

Factor Analysis of Pseudoscientific Beliefs

Previous research has used factor analysis to explore the number of statistical dimensions within the universe of pseudoscientific beliefs. Results of such studies are contradictory. Researchers have found that a factor analysis of a wide array of pseudoscientific beliefs will produce only one factor (Eve & Harrold 1986), two or more factors (Tobacyk & Milford 1983), or a "Biblical fundamentalism" factor which is inversely related to other non-religious pseudoscientific beliefs (Bainbridge & Stark 1981). Because of the lack of consensus on the number of statistical dimensions of pseudoscientific belief in the preexisting literature, we subjected the entire pool of items in our questionnaire to a PA-1 factor analysis. The resulting scree plot of the eigenvalues was used to determine the number of meaningful factors that could be extracted.

The factor analysis of our sample of high school life science and biology teachers produced only one meaningful factor. It can be logically interpreted as a "Biblical literalism" factor because most of the items reflect how strictly the respondent interprets Biblical scripture. Eleven of the separate items analyzed had factor loadings high enough to warrant placing them together in a scale designed to assess a respondent's commitment to Biblical literalism. The items are listed below.

1. Satan is a real personality working in the world today.
2. Regardless of the fact that the earth may be extremely old, the fossil record does not provide persuasive evidence that there has been any significant evolutionary change through time.
3. Heaven really exists.
4. Black magic exists and has real power.
5. Each person has a soul that survives after his or her physical death.

6. One can believe in the Bible and creation, or in atheistic evolution; there is really no middle ground.
7. Dinosaurs and humans lived at the same time.
8. Adam and Eve were the first human beings and were created by God.
9. The Bible's account of creation should be taught in public schools as an explanation of origins.
10. The Bible is an authoritative and reliable source of information with respect to such scientific issues as the age of the earth and the origin of life.
11. There is a good deal of scientific evidence against evolution and in favor of the Bible's account of creation.¹³

The "non-Biblical" belief items in our survey did not cohere well enough to produce any meaningful factors and, therefore, could not be combined into a scale. As a result, the greater portion of the remainder of this analysis will focus on the correlates and implications of respondents' scores on the "Biblical literalism scale." An examination of the correlates of each separate type of non-biblical belief requires separate and lengthy analyses that cannot be presented in entirety here. We believe, however, that our focus on the issue of Biblical literalism is appropriate for reasons other than analytical economy. As Kehoe (1987) has persuasively argued, only this type of pseudoscientific belief is specifically hostile to mainstream science, manifests the coherence of a complete world view and threatens to impose its world view on the scientific community.

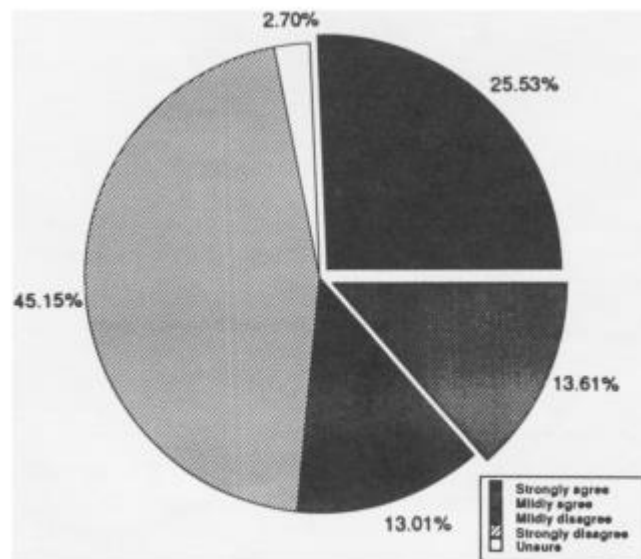


Figure 7. "There are sufficient problems with the theory of evolution to cast doubts on its validity."

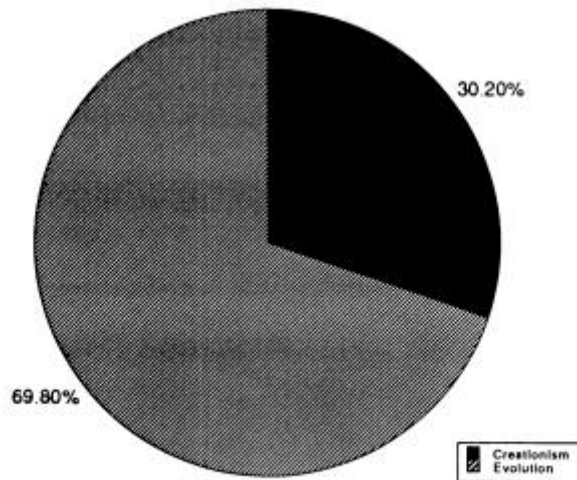


Figure 8. "If you had to teach only creationism or only evolution, which would you choose?"

Correlates of Biblical Literalism

Because there is almost no pre-existing research which has systematically examined the pseudoscientific beliefs of teachers, hypotheses concerning the correlates of such beliefs among teachers must be extrapolated from research on college students or inferred from results obtained from samples of the general public. Previous research by Harrold and Eve (1987) suggested only a few demographic correlates of creationist beliefs among college students. Creationism was not found to be correlated with students' age, sex, or level of parental education. It was, however, found to be related to the students' race and region of origin. Harrold and Eve found that creationist belief levels were higher among black, Hispanic and Asian students, and in the southern states.

Unfortunately, our sample of science teachers was too small to allow a reliable examination of racial or ethnic differences in pseudoscientific belief. While it is indeed the case that ethnic minority teachers are underrepresented in the population, they were even more underrepresented in our sample of teachers. Our sample was 94 percent white, 4 percent black, 2 percent Hispanic and 1 percent Oriental. For this reason, a thorough examination of ethnic or regional variation in pseudoscientific beliefs among secondary school science teachers must await a larger sample.

While college students' belief levels in Biblical literalism have been found to be around 20 to 25 percent in most regions, they have been reported to be significantly higher in the South (Harrold & Eve 1987). We expected the same pattern to emerge in our sample, but were surprised to find that a teacher's level of Biblical literalist belief was not correlated either with region of birth or the geographic area where he or she is now teaching.

Previous research on students has found fairly strong tendencies for students from evangelical (and especially fundamentalist) affiliations to be more creationist (Harrold & Eve 1987). Contrary to what would be expected, we did not find the respondent's choice of religious affiliation to be significantly correlated with level of belief in Biblical literalism.

Neither age, level of parental education, nor sex of the respondent proved to be correlated to Biblical literalist beliefs. While women represented only 27 percent of the sample (compared

to 24 percent of all high school science teachers nationally [National Science Foundation 1982]), their numbers were sufficient to permit a reliable statistical test. Our findings regarding sex differences in Biblical literalist belief appear to challenge the traditional view that women are more religious than men.

While the respondents' actual choice of religious affiliation did not prove to be related to Biblical literalist belief, the importance of religion in their lives was correlated with scores on our scale (Pearson's $r = .6$; significance level $> .001$). Also, the reported frequency of attending church was positively correlated with Biblical literalism (Pearson's $r = .6$; significance level $> .001$). Those respondents who indicated that religion was more central to their lives and those who attended church regularly were more likely to hold Biblical literalist beliefs. In fact, those who attended church once a week or more were more than twice as likely to express strong belief levels in Biblical literalism. A logical interpretation of these findings is that the religious socialization of these individuals has affected their personal perceptions of reality far more than has their science education.

We expected to find that teachers with advanced degrees, especially in the sciences, would score lower on the Biblical literalism scale because they had received more indoctrination into the "scientific way of knowing." Yet, neither the subjects our teachers majored in while in college, nor the level of their terminal degrees, were correlated with Biblical literalist beliefs. However, the type of college or university where they received their terminal degree (i.e., public, private, or private and religious) was modestly associated with Biblical literalism (Cramer's $V = .22$; significance level $> .001$). Teachers with degrees from private religious institutions were more likely to have higher Biblical literalism scores. We also found weak inverse associations between the teachers' literalism scores and whether they had taken certain courses while in college. Those who had had courses in anthropology, geology, or astronomy were somewhat less likely to be Biblical literalists (Cramer's V 's of $.2$ in each case; significance levels = $.05$). Those who reported having taken a Bible study course were considerably more likely to have a high literalism score (Cramer's $V = .35$; significance level $> .001$). It is difficult to determine, however, whether taking such courses changed Biblical literalist belief levels, or whether respondents self-selected into courses that were compatible with their pre-existing beliefs. Further research will be required to establish the direction of effect in these relationships.

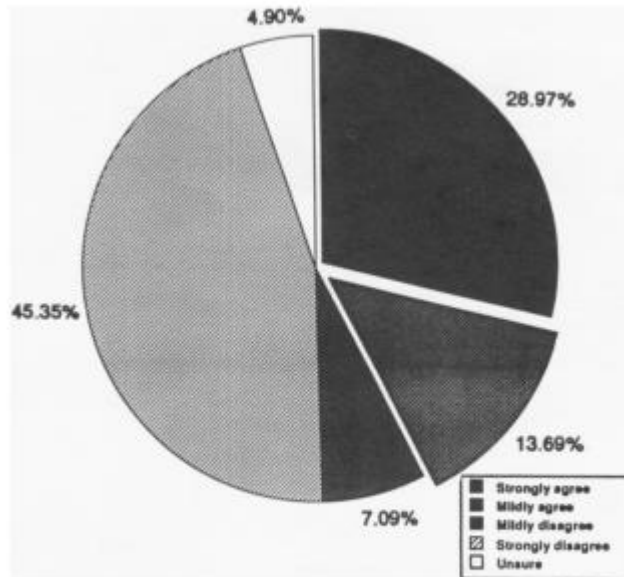


Figure 9. "Regardless of the validity of the concepts of special creationism and evolution, proponents of each should be allowed equal time to express their views in science classes in school."

Demographic factors, then, are almost completely unrelated to scores on the Biblical literalism scale for our sample. In some cases this is likely to be due to insufficient numbers in the sample, yet, on the whole, it would appear that any strong correlations between belief in Biblical literalism and demographic characteristics in larger samples is unlikely. Overall, in our sample of teachers, self-reported religiosity and formal religious education appear to be the only variables that exert a significant influence on belief in Biblical literalism.

Those Who Would Prefer a Creationist Classroom

As logic would suggest, we found a strong correlation between high scores on the Biblical literalism scale and responses to the following question, "If you had to teach only evolution or only creationism in your science classes, which would you choose?" (Cramer's $V = .77$; significance level $> .001$). This finding is compatible with our assumption that given an ordinary degree of autonomy in the classroom, teachers' beliefs may influence what is taught and how it is taught.

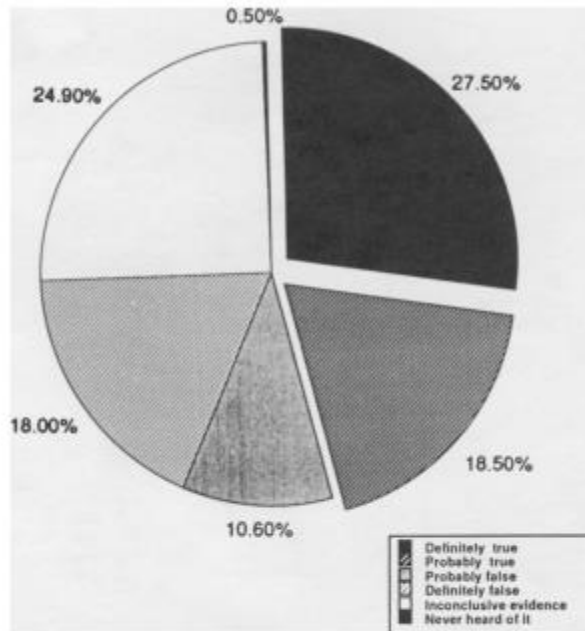


Figure 10. "It is impossible for the living to communicate with the dead."

As would be expected, the correlates of teachers' choice of "origins perspective" were quite similar to the correlates of Biblical literalism. Demographic characteristics were largely unrelated to the choice of an origins perspective. One exception was whether the respondent thought of himself/herself as a person from a farm, rural town, small town, small city, or large city. This variable was weakly associated with the teachers' choice of an origins perspective. Those teachers who would choose to teach only creationism if forced to make a choice were more likely to be from rural backgrounds (Cramer's $V = .23$; significance level $> .05$). This finding is intriguing in light of recent research which indicates that among scientists, biologists are disproportionately likely to be from rural backgrounds (Xie 1988).

Once again, educational background and preparation for teaching were not associated with the dependent variable (choice of an origins perspective to teach), with the exception of the nature of the college or university-public, private, or private and religious ($V = .28$; significance level $> .001$). Those teachers who graduated from private religious schools were slightly more likely to indicate a preference for creationism. Exposure to anthropology and geology courses in college had modest inverse associations with the respondent's choice to teach creationism (V 's = $.22$ and $.21$, respectively; significance level $> .01$). Exposure to college-level Bible studies courses, on the other hand, had a moderate positive correlation with the choice ($V = .33$; significance level $> .001$).

Teachers were more likely to say that they would choose creationism over evolution if they had "ever received strong pressure from" school administrators or school board members (V 's of $.31$ and $.29$, respectively; significance level $> .001$). Similarly, those teachers who opted for creationism were more likely to indicate that they would teach creationism if they received strong pressure in the future from students, parents or school administrators to do so (Cramer's V 's of $.42$, $.53$ and $.45$, respectively; significance levels $> .001$).

The choice of a creationist perspective in the classroom was also correlated with the respondents' political stance (conservative, moderate, liberal, or radical) (Cramer's $V = .42$; significance level $> .001$), with creationists being more likely to be politically conservative. It is particularly interesting to note that while political stance is closely correlated with the teacher's choice of an origins perspective, religious affiliation is not.

Correlates of Other Pseudoscientific Beliefs

Only four of the items measuring pseudoscientific belief levels not associated with Biblical literalism proved to be correlated with any of the demographic variables for our sample:

1. "Bigfoot" (Sasquatch) is a real animal roaming the woods in the American northwest.
2. Some people can predict future events by actual psychic power, not just by intuition.
3. Atlantis was a continent that actually existed and was the home of a great lost civilization, but now lies beneath the ocean.
4. Reincarnation really happens.

Certain of the education variables were modestly correlated with belief levels on these pseudoscientific items. Teachers who had taken anthropology courses while in college were less likely to believe in psychic power (Cramer's $V = .24$; significance level $> .05$), and those who had taken psychology courses were slightly less likely to express belief in Bigfoot (Cramer's $V = .15$; significance level $> .05$). Those who had taken astronomy courses while in college were less likely to express belief in the lost continent of Atlantis (Cramer's $V = .26$; significance level $> .05$). Finally, those teachers holding master's degrees were less likely to indicate that they believed in reincarnation (Cramer's $V = .23$; significance level $> .05$). The fact that educational background is not strongly associated with belief in these types of pseudoscience for the teachers in our sample might be interpreted to suggest that higher education does little to eradicate this type of pseudoscientific belief. However, it is likely that there is a "threshold effect" operating for this sample, in that all the teachers hold four-year degrees, and the possession of such a degree alone may serve to significantly reduce such beliefs.

The female teachers in our sample were more likely than the male teachers to indicate they believed in the lost continent of Atlantis (Cramer's $V = .26$; significance level $> .05$). The only other variable correlated with a belief in Atlantis was the teacher's choice of a preferred origins perspective for the science classroom. Those teachers who indicated they would choose creationism over evolution were more likely to express a belief in Atlantis. (Cramer's $V = .26$; significance level $> .05$). This finding is rather puzzling given that previous studies have found belief in religious forms of pseudoscience to be inversely related to belief in other forms of pseudoscience (Bainbridge & Stark 1981). We did find a preference for teaching creationism over evolution to be inversely correlated with belief levels in reincarnation (Cramer's $V = .47$; significance level $> .001$), however, indicating that pseudoscientific notions associated with differing religious perspectives are incompatible.

Because so few correlates of "non-Biblical" pseudoscientific belief items were found in our study, it appears that other factors which we did not examine must play an important role in influencing such beliefs. Potential areas that might be explored in further research include cognitive biases,¹⁴ the influence of the electronic media and personality factors.¹⁵

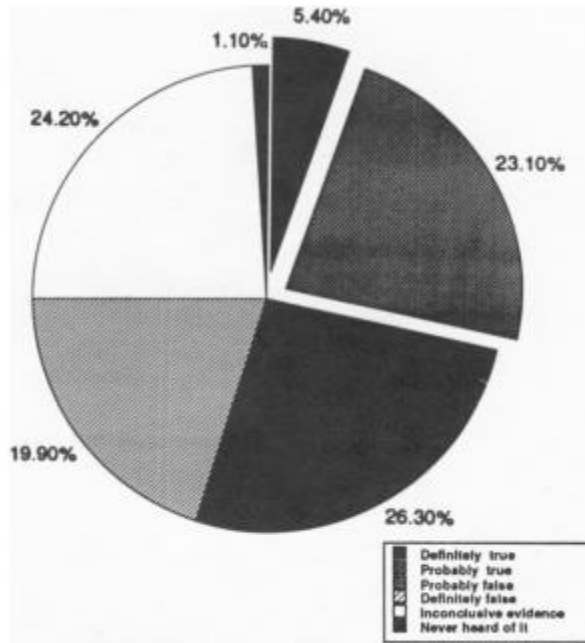


Figure 11. "Some people can predict future events by actual psychic power, not just intuition."

Conclusions: Implications of Teachers' Pseudoscientific Beliefs for Science Education in the United States

In light of our findings it seems quite reasonable to assume that a significant proportion of high school life science and biology teachers hold many beliefs which are at odds with mainstream science. The most commonly held "type" of pseudoscientific belief in our sample of teachers is Biblical literalism (which includes a belief in special creationism). This does not seem coincidental, since it is only for this type of belief that there has been substantial effort to influence what teachers present in the classroom. Creationists have long been active in their attempts to impose their religious beliefs on the general population, beliefs which are based on a literal interpretation of the King James version of the Bible. Because the Supreme Court rejected the earlier demands for equal time from creationists on the ground that creationism is a religion but not a science, a new "creation science" strategy was developed in the 1970s. Advocates of "creation science" claim that a literal interpretation of the Bible can be scientifically validated.¹⁶ Creation scientists now fund their own research institutes and publish their own journals.¹⁷ However, the research issuing from the creation science institutes often deviates from the scientific method and, as a result, is not acceptable for publication in mainstream scientific journals (Nelkin 1982; Schadewald 1982).

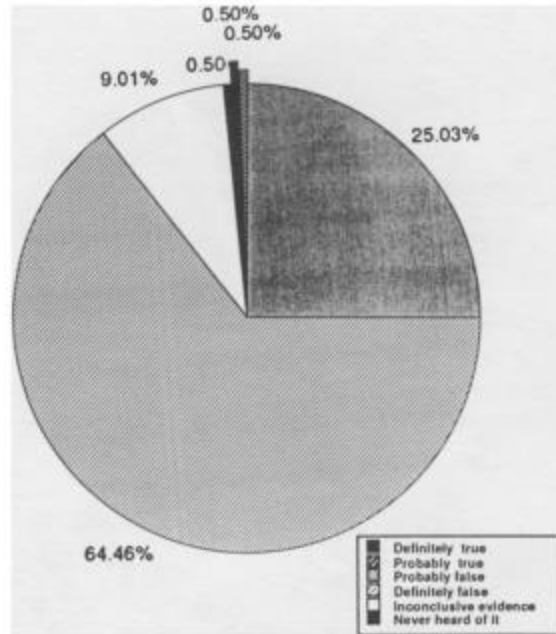


Figure 12. "Astrology is an accurate predictor of people's personalities."

"Creation science" is particularly attractive to science teachers (especially biology teachers) who are Biblical literalists because it supports their religious beliefs as well as the presentation of such beliefs in the science classroom. "Creation science" enables creationist teachers to "hold their heads high" in the company of their colleagues (Barker 1985). But the influence of "scientific creationism" is by no means limited to teachers who are Biblical literalists. In recent years, creationists in the U.S. have intensified grass roots campaigns to influence local school districts as well as individual teachers to either present creationism in the classroom on an equal time basis with evolution, or to exclude evolutionary views from the curricula altogether. Strategies for influencing teachers and administrators include the use of mass mailings of creationist booklets designed to help teachers effectively present creationism and the placement of creationist articles in local or regional biology teacher association journals (Bennetta 1988). Such materials can be quite influential when teachers are somewhat uncomfortable with their own scientific knowledge of evolution (Zimmerman 1987), and also in instances where there are pressures from students, parents, or administrators to present a creationist component in the classroom.

The content of biology textbooks has also been under fire from "scientific creationists." Recent studies have shown that the coverage of evolution in high school biology textbooks has declined sharply in the 1970s and 1980s (Skoog 1979, 1984; Scott 1987). For example, Skoog (1984) finds that

Of six high school biology textbooks published in the early 1970s and revised in the 1980s, the coverage of evolution declined in four and remained the same in two. Five biology textbooks published in the 1980s, but not in the 1970s, tended to cover evolution less extensively than textbooks published 10 years ago.

It seems likely that the successes of the "scientific creationists" in influencing the content of both high school science class curricula and textbooks could negatively affect the quality of biology education in the U.S. Ample evidence exists, in fact, to suggest that there is reason for serious concern regarding the quality of science (especially biology) education in the U.S. An alarming study recently conducted by the International Association for the Evaluation of Educational Achievement (1988) assessed the scientific achievement levels of high school science students from 13 developed countries between the years 1983 and 1986. The study found that the U.S. scored quite low (never better than eighth place) in all the areas of scientific knowledge tested. Interestingly, the U.S. students scored absolutely last in biology. The association's final report states that

The biology results are especially low (in the U.S.). For a technologically advanced country, it would appear that a reexamination of how science is presented and studied is required.

The National Science Board's Commission on Precollege Education in Mathematics, Science, and Technology also expressed grave concern over the state of science education with the following statement:

Alarming numbers of young Americans are illequipped to work in, contribute to, profit from and enjoy our increasingly technological society. Far too many emerge from the nation's elementary and high schools with an inadequate grounding in mathematics, science and technology (National Science Foundation 1983).

The Science Report Card published by the Educational Testing Service (ETS) (1988) also indicated that science proficiency levels were distressingly low in their 1986 assessment. ETS expressed the opinion that only 7 percent of U.S. high school seniors were prepared for careers in science.

Our finding that many high school biology and life science teachers endorse pseudoscientific beliefs is, in our view, further evidence for sub-standard biology education in the United States. We believe the analysis presented herein suggests that many teachers are not only failing to impart basic information on the scientific method to their students, but are also likely to be misinforming students because of their own beliefs in pseudoscience.

In conclusion, this exploratory study finds sufficient levels of pseudoscientific belief (especially Biblical literalism) among high school life science and biology teachers to warrant significant concern. Contrary to the findings of previous studies, the holding of these beliefs does not seem to be limited merely to teachers with less education (B.A. degrees only), nor to those in geographic regions such as the South. If one assumes—as our preliminary research can only suggest—that teacher's beliefs influence what is actually presented in the classroom, further research is clearly needed to explore the extent to which pseudoscientific information is transmitted to students in science classes. Our findings also indicate that the strategies for improving science education and rates of scientific literacy in the U.S. should be focused not only on methods of teaching science, but even more importantly on the very content of science instruction.

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