Exploring the Social, Moral, and Temporal Qualities of Pre-Service Teachers' Narratives of Evolution

Deirdre Hahn — Division of Psychology in Education, College of Education, Arizona State University, PO Box 878409, Tempe, Arizona 85287 Deirdre.Hahn@asu.edu

Sarah K Brem — Division of Psychology in Education, College of Education, Arizona State University, PO Box 870611, Tempe, Arizona 85287 Sarah.Brem@asu.edu

Steven Semken — Department of Geological Sciences, Arizona State University, PO Box 871404, Tempe, Arizona 85287 semken@asu.edu

ABSTRACT

Elementary, middle, and secondary school teachers may experience considerable unease when teaching evolution in the context of the Earth or life sciences (Griffith and Brem, in press). Many factors may contribute to their discomfort, including personal conceptualizations of the evolutionary process - especially human evolution, the most controversial aspect of evolutionary theory. Knowing more about the mental representations of an evolutionary process could help researchers to understand the challenges educators face in addressing scientific principles. These insights could inform educators of alternative methods in providing support and assistance. In this study, we examined pre-service teachers' conceptual representations of an evolutionary process through their personal narratives of evolution for an imaginary humanoid species on a far-off planet. The imaginary creature participants described tended to resemble humans in both form and evolutionary history. The narratives had a tendency to link evolutionary changes with social and moral consequences. Those whose narratives closely paralleled human evolution also seemed to have difficulty envisioning evolutionary changes that would take the species past current human development and into their evolutionary future. The connection among social and moral issues, evolution, and difficulties envisioning the future may provide important clues into pre-service teachers' conceptualizations of human evolution. Addressing personal barriers and misunderstandings that might impede geoscience education may become an effective tool for teaching scientific principles.

INTRODUCTION

Few people remain indifferent about teaching evolutionary theory in America (Dennett, 1995). Research regarding the teaching and learning of evolutionary theory has focused heavily on student comprehension and misconceptions (Bishop and Anderson, 1990; Cobern, 1994; Dawkins, 1976; Demastes et al., 1995; Moreland and Reynolds, 1999; Piburn et al., 1986; Zimmerman, 1987), or on curricular and policy issues (Shankar and Skoog, 1993; Skoog, 1984). Less attention has been given to the social and personal consequences that arise from the complex and controversial relationship between evolutionary theory and issues such as racism, social Darwinism, eugenics, and other ethical dilemmas (Farber, 1994; Franklin, 1991; Moore, 1998, 1999; Griffith and Brem, 2003; Moreland and Reynolds, 1999; Wolpoff and Caspari, 1997).

Brem, Ranney and Schindel (2003) found that when people accept evolutionary or creationist accounts of life on Earth, they tend to have a negative perception of the consequences of accepting evolutionary theory. That is, both evolutionists and creationists tend to believe that accepting evolutionary theory will result in a greater ability to justify or engage in racist or selfish behavior, and will reduce people's sense of purpose and self-determination. Further, Griffith and Brem (in press) found that in-service science teachers frequently share these same beliefs and to avoid controversy in the classroom, the teachers created their own boundaries in curriculum and teaching practices.

There is a historical precedent for uneasiness around evolutionary theory, particularly given its use to explain and justify actions performed in the name of science. Guthrie (1998) suggested examples of gross misuse of science related to an exploitation of the principles and language used to describe evolution: the "Kallikak bad seed" philosophy of human reproduction; Tuskeegee non-consented research on Black men; government sanctioned sterilizations performed in prisons and mental institutions; and intelligence testing used to extend "racially inferior" labels to Native Americans and Mexican Americans.

Post-World War I American was marked with disillusionment and fear regarding human progress in the face of violence and worldwide conflict (Moore, 1998, 1999). American and European biologists, alike, believed early interpretations of Darwin's concept of natural selection was distorted by the German militarism to promote and create war (Farber, 1994). Moore claimed that post-WWI American culture developed a "...nostalgia for the relative simplicity of prewar life, combined with a perceived decline in morality [that] led many people to rely increasingly on their religious faith for stability and comfort" (p. 487).

The 1925 Scopes trial exemplifies the public treatment of evolutionary theory following the first World War whereby human evolution became tied to ideas of evil, bigotry, morality, atheism, and images of monkeys turning into man (Moore, 1998, 1999). The atrocities committed by the Nazis during World War II further stigmatized evolutionary theory in the public eye. Postwar America saw an even deeper resurgence of faith and morality, particularly by American fundamentalists, who turned to education and politics to strengthen the image of morality. Today, fears of abandoned faith, unethical scientific practices, concern for human morality, and a loss of purpose continue to be coupled with evolutionary theory (Brem et al., 2003; Dawkins, 2003; Gitt, 1995; Ham, 1998).

Wolpoff and Caspari (1997) reveal that evolutionary biology is frequently categorized as the study of human race or human types. Thus, when theories of evolution are reduced to mere racial differentiation, existing unease between those teaching scientific principles of human origin and those that feel threatened by it becomes exacerbated. By comparison, the value of collecting per-

sonal narratives on a controversial topic such as evolution rests in how researchers can provide participants safety in transcending the potential discomfort of reporting. The historical evidence that non-scientists tend to frame evolutionary theory in social and moral terms suggests adhering to such perceptions involves the use of fragmented and simplistic interpretations of meanings in change over time. For this reason, telling an evolutionary story may provide research participants a creative and non-judgmental option of revealing personal interpretations of evolutionary change and time without earthly limitations.

Conceptually, understanding evolution through "deep time" (McPhee, 1981) is difficult because it is explained after the fact and is affected by complex, stochastic events. The odds that things would turn out similarly if we could re-run evolution of the universe or life on Earth are infinitesimally small (Dennett, 1995; Gould, 1989). In a forward time scale, evolutionary theory may appear to have very limited predictive power for some people and it may create discomfort for humans to visualize prospective natural events in the future.

Alternatively, human dependence on cognitive memory for interpreting a time scale of events to understand what the future may bring (Suddendorf and Corballis, 1997) could interfere with our capability to visualize vast time scales. An unwillingness of teachers to engage meaningfully with evolution may derive from the great difficulty of comprehending the geologic time frame in which biological evolution takes place. Although the magnitude of deep time is readily apparent from observations of geological processes and features (Palmer, 1989; Zen, 2001), attaching evolutionary principles onto deep time has proven challenging for students, teachers and even for many scientists to grasp (Dennett, 1995; Trend, 2000).

Given the available evidence in how educators conceptualize human evolution we observe two central, yet often overlooked elements in people's discomfort with evolution: a tendency to associate evolutionary principles with historical ethical and moral consequences, and considerable difficulty imagining the future on the immense evolutionary time scale. In this study, we chose to explore these elements with pre-service teachers.

Research by Shankar and Skoog (1993) showed teachers in Texas avoided teaching evolution even after legal proceedings affirmed their right to teach the subject. Griffith and Brem (2003) illustrated that teachers shared many of the same ethical and moral concerns of a layperson about evolution, while cognitive research maintains that deep time is a difficult notion even for individuals with significant scientific training (Dennett, 1995). In short, teachers have the power to influence the development of novel beliefs and attitudes for students around evolutionary concepts. Examining pre-service teachers' beliefs and attitudes may reveal how beginning teachers can affect science-learning outcomes when there exists a genuine unease surrounding evolution. Thus, examining pre-service teachers also permits us to collect longitudinal data regarding the development of scientific beliefs after they enter the workforce. This paper reports on the first wave of data collection with this pre-service teacher population.

METHOD

Extracting participant models of evolution, especially human evolution, is challenging. In addition to the discomfort participants may experience by "going on the record" with personal beliefs about a controversial subject even anonymously, accounts of actual evolutionary processes do require specific prior knowledge. Participants may become hesitant or embarrassed if unfamiliar with the details of these processes, even if evolutionary theory by itself causes no discomfort.

One possible solution to this dilemma is to ask participants to construct an evolutionary narrative about a fictional "humanoid" species. Genet (1998) developed a college course that explored the concept of "epic evolution," suggesting students would better understand science as a story. His curriculum details epic evolution as scientifically objective, culturally relative, and as meeting the need for personal understanding of a complex theory. This method also appears to tie people to the future. Creativity research shows that people tend not to move far from their actual experience and beliefs when creating "novel" characters, while prior knowledge and current beliefs constrain innovation, especially when specific examples are provided (Costello and Keane, 2000; Ward and Sifonis, 1997, Smith et al., 1993). Our rationale for asking participants to invent a new humanoid species within a storyline was to relieve hesitation in responses that may be due to internal conflict or lack of knowledge. Participants would not have to make claims about human beings directly, yet we still expected them to draw heavily on existing personal conceptions of human evolution to answer the open-ended questions. Although this cannot fully address all discomfort associated with such a task, we believed it would provide the teacher participants with "breathing room" while still getting at the basic questions of how they conceptualize the evolutionary process of humans or human-like species. Moreover, inventing this narrative does not require prior knowledge of specific species or events, nearly eliminating the problems associated with a lack of expertise in the evolutionary sciences.

We did not begin this research with any prior assumptions of what responses would constitute a "correct" interpretation of evolution by the pre-service teacher participants. We did not expect that thematic patterns in their collected responses would necessarily map directly onto any existing classifications, such as the "creation/evolution continuum" of Scott (2000). Instead, we simply anticipated that thematic differences identified within the narratives would reflect differing conceptions of the evolutionary process.

Participants - Our study focused on pre-service teachers in order to capture fundamental conceptions of evolution without the influence of the more mature techniques that experienced in-service teachers utilize. In essence, pre-service teachers have not learned to adapt to the challenges of teaching evolution. We intentionally recruited a range of different majors in education and not just those planning to teach science, in order to determine a more general set of attitudes toward understandings of evolutionary theory.

The participants were 40 pre-service teachers at Arizona State University. A total of 20 participants finished all three humanoid scenarios and one participant completed two scenarios. This was lower than anticipated because incomplete and illegible

Demographic Data and Questions Age (M=23.38)	N's reporting	Responses
Gender	21	Male = 1 Female = 20
Ethnicity	21	Asian = 4.8% Latino/Hispanic = 9.5% White = 81%
What is your major in the Teacher Education Program?	21	Elementary Ed = 90.5% Secondary Ed = 9.5%
What subjects do you plan to teach?	10	Math = 14.3% English = 4.8% Social Studies = 9.5% All subjects = 4.8% Science = 14.3% Unkown = 47.6%
Number of completed high school science courses.	21	2 to 3 courses = 52.4% 4 to 4 courses = 47.6%
Number of completed college science courses.	21	0 to 1 courses = 4.8% 2 to 3 courses = 76.2% 4 to 5 courses = 9.5% 5 + courses = 9.5%
Have you ever had a course that taught evolution?	12	Yes = 41.7 No = 58.3%
Do you believe in a supreme being?	21	Yes = 66.7% No = 19.0% Don't Know = 14.3%
What is your religious affiliation?	18	Christian = 88.9% Non-Christian = 11.1%

Table 1. Participant profile.

handwriting eliminated many of the surveys. Participants who indicated that they did not intend to pursue teaching careers were not included. Table 1 provides a summary of demographic data on the 21 pre-service teacher participants.

Design - Pre-service teachers responded to a story where they were asked to imagine being space travelers journeying to a distant planet populated by live humanoid creatures. Across a 200,000-year time period, participants were asked to imagine and describe the evolution of humanoids on a far-off planet. Participants were instructed to describe: (a) the first (Early) humanoids encountered on the planet; (b) the second (Middle) humanoids that had evolved for 100,000 years; and (c) a mutated (Late) species that had evolved an additional 100,000 years. Each set of responses was an opportunity to examine participant cognition about a humanoid evolutionary process decoupled from direct reference to human beings or other life on Earth. Most responses took the form of bulleted lists, narratives, or illustrations, while some participants used a combination of these formats.

Analysis - Responses were examined at the level of short phrases and bulleted points. Phrases were considered groups of words that started with a capital letter and ended with blank space or a punctuation mark. Other phrases were defined as groups of words preceded by some type of bulleted mark and ending with blank space or punctuation. Whole responses to scenarios were the combinations of phrases written within a box printed the size of one-half of letter-sized white paper. A total of 438 phrase responses were analyzed from the 21 participants.

Rater-coder - We used a content analysis to examine possible patterns of the type of humanoid within each scenario based on similarity of language used in descriptions. This was done using raters who sorted the descriptions. The raters were five graduate students who independently examined each individual phrase and then attempted to categorize the phrases into general groupings. For example, each rater received a set of individual phrases printed on strips of paper for each of the three scenarios (Early, Middle and Late), and were instructed to group the phrases within scenarios into categories. As with any qualitative coding procedure, what we are inevitably reporting is not the patterns produced by the participants, but the patterns produced by the participants and raters interacting. The coders reached a consensus, with disagreements resolved through discussion. Examples of participant answers and rater-coder categories are given in Table 2.

RESULTS

According to the rater-coders, the humanoids the participants invented tended to either be unusual beings with forms and abilities markedly different from those of humans (i.e., lighter than air, no corporeal form, psychic communication), or they resembled common stereotypes

Rater-coder categories	First Humanoid (Early)	100,000-year old Humanoid (Middle)	200,000-year old Humanid (Late)
Physical Description	Ape looking, not upright, large head, hairy, thick skin, muscular, long fingernails, dark in color, needs teeth to eat meat Hairy, no beauty, long fingernails Single celled, no features, no hair, smooth	Upright, modern man, less muscular, fatter, less hair, smooth and light skin, tall, has thumbs Clothed, shaves Larger brain Humanoids can choose physical traits Multi-celled	Floating with no form Bodies engineered by science Small teeth, no hair, white skin, good eyes, fast 4 arms, 4 legs, eyes on back of head, no skin, less body Big brain Supreme beings
Intelligence	No identity, no intelligence, not advanced Tool user, solves problems, learns	Religious identity Builds, problem solver, machines, tools, jobs Technology Robot advance begins, human cloning	Mentally inferior due to science Analyze, curious, explores Uses technology Alien-like
Communication	Minimal communication, not advanced in language	Increased verbal communication Computers	Telepathy Advanced complex communication
Environment	Environment provides diet, eats meat, vegetables, cave dwellers	No hunting, food accessible, manufactured food No hunting needed, not dependent on environment to survive	Hot Explores oceans and skies Adapts to new environments
Social Skills	Minimal, no social hierarchy, cave-dwellers, small groups small population	Thrive in social groups Larger population	No social interactions Small groups Family unit important
Behaviors	Aggressive, hunter/gatherers Relationships only for reproduction	Lazy Angry Resentful Aggressive Warring Violent	Selfish Ill-mannered Ignorant Disregards others and cares just for family

Table 2. Examples of participant answers and rater-coder categories.

of human evolution. This latter sort of narrative was far more common, suggesting that participants tended to use human evolution as their model, as we had expected, and we concentrate on this model for the remainder of this paper.

The Early humanoids commonly had human-like teeth, large heads, muscular bodies and long fingernails, survive in a hostile environment, and depend on scrounging and hunting for food. They ranged from having no intelligence to being able to solve problems and learn; some had the ability to communicate and frequently exhibited a need for social interaction in small groups.

The Middle humanoids were mostly upright and seemed to have taken on a dominant role in society. They were no longer as hairy, lost the long fingernails, and developed skin that was smoother, lighter and less muscular. Their brains were larger than those of the earliest humanoids. They practiced religion, solved problems, had jobs, and built machines and homes. They no longer hunted for survival, as food was readily accessible. They thrived on social interactions and appeared to express emotions such as anger and resentment. Participants seemed to have more difficulty in describing the Late humanoids, those farthest in the future. These narratives were generally shorter, and likely to repeat or overlap with the Middle narratives.

We saw a trend for participants to link their evolutionary timeline descriptions with negative/cautionary characteristics (i.e., greedy, selfish, unhealthy), or positive/optimal characteristics (i.e., happy, caring, healthy diet). Cautionary narratives began with the earliest humanoids depicted as cave dwellers who led a simple life, and were usually happy and healthy. They fall victim to technology, greed, and mechanization. In the Late group, the cautionary humanoids were selfish, ill mannered, and lacked empathy; they subsisted on junk food and were often obese, or reverted back to caveman status.

Likewise, the optimization narratives began with cave dwellers who were brutish, struggle for survival, and have animal-like appearances and behaviors. Over time, technology, greater intelligence, and ability allowed the Middle humanoids to create a happier and more productive existence. By the end of these narratives, the Late optimized humanoids were caring, had elaborate acts of ritual and expression, ate a varied,

healthy diet, and had moved closer to the body plan of modern humans. Physically, they usually had less body hair and modern teeth and nails.

For each type of timeline, Late characterizations were the least descriptive, perhaps an indicator of the difficulties participants had in projecting evolution into the future. Overall, the three timeline descriptions generally followed a moralistic and apparent dichotomous theme (greedy versus happy; selfish versus caring; unhealthy versus healthy) in conceptualizing an evolution process.

DISCUSSION

The tendency for participants' narratives to take on a dichotomous cautionary or optimization direction informs the potential social and moral uncertainty that may color our understanding of evolutionary theory. The trend of adhering to an "either/or" approach to the origin of life creates an internal choice not readily apparent in just knowledge evaluation alone. In the participants' narratives, the species is rewarded or punished for its excesses or achievements, giving evolution an either positive or negative ethical and moralistic tone. Also, as we predicted, participants' descriptions of the humanoids farthest in the future were the least detailed. This outcome is consistent with other research regarding the difficulties many people have in grasping deep time, and illustrates how participants' creativity may become constrained by their limited knowledge of extreme time frames - ultimately the human future is unknown.

Differences between mid-time (Middle) and future (Late) humanoids yielded similar descriptions. In other words, scenario responses generally indicated the evolution of the imaginary humanoids reached a stage roughly equivalent to the current state of actual humans. This finding suggests participants share a belief that contemporary human beings are at the evolutionary pinnacle of our species, which is in line with general anthropocentric beliefs about human evolution (Wolpoff and Caspari, 1997). More recent research conducted with undergraduate students suggests a general belief that geologic change also "stops" in the present (Libarkin et al., 2005). This line of reasoning may have the effect of alleviating any pressure for students or educators to understand the process of evolution.

Moreover, aspects of moral and social implications (i.e., aggression, no intelligence, anger, progressively lighter skin, cloning concerns, loss of faith, resentment) and future-time predictions (i.e., mutated physical forms, no emotions, technologically advanced, science is a threat, ignorant, selfish) are identified as characteristics that can contribute to teacher unease and hesitation around teaching evolutionary theory. Religious education, Internet, news, movies, television, comics, and video games may consciously or unconsciously contribute to personal concepts of evolutionary narratives participants described. Underlying ambivalence seems related to a sense that evolutionary theory may promote racism, discrimination, abandonment of faith and intentional manipulation of what makes us diverse and mortal (Brem et al., 2003; Griffith and Brem, 2003; Dagher and Boujaoude, 1997). Presumably, perceived ethical and social costs call into question alleged penalties of accepting evolution.

The results of this study suggest pre-service science teachers could benefit from: (a) an explanation of misconceptions in the ongoing relationships of social/moral consequences and evolution; (b) learning to envision the future; and (c) understanding the unification of biological and geological evolution. Attention to these areas could significantly reduce unease and hesitation for pre-service teachers who will eventually address or explain evolutionary concepts to students while in-service.

This research program is in its infancy and we acknowledge a more diverse participant sample, including gender balance and an expanded ethnic background, would benefit outcome clarification. Further, comparisons of personal narratives to quantitative examination of attributes, belief systems, and values may verify the extent to which engaging in evolutionary theory might affect future teachers. We need to determine whether a connection can be made between the narratives teachers create and the level and nature of their unease around teaching evolution. The relationship of a fictional, far-off humanoid species narrative to humans on Earth must also be further explored. Nevertheless, we believe these initial findings provide important clues about pre-service teachers' conceptualizations of human evolution and personal barriers that might impede ongoing, effective science education.

ACKNOWLEDGEMENTS

This research is supported by National Science Foundation grant REC-0133446 to the second author. All opinions, findings, conclusions, and recommendations presented in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation. The authors wish to thank Angelica Prado-Stern, Sian Proctor, Luis Fernando Romero, Joyce Van Walsum and Debbie Zambo for their support and contribution to this research.

REFERENCES

Bishop, B.A., and Anderson, C.W., 1990, Student conceptions of natural selection and its role in evolution, Journal of Research in Science Teaching, v. 27, 415-427.

Brem, S.K., Ranney, M.B., and Schindel, J., 2003, Perceived consequences of evolution: College students perceive negative personal and social impact in evolutionary theory, Science Education, v. 87, p. 181-206.

Cobern, W.W., 1994, Point: Belief, understanding and the teaching of evolution, Journal of Research in Science Teaching, v. 31, p. 583-590.

Costello, F., and Keane, M.T., 2000, Efficient Creativity: Constraints on conceptual combination, Cognitive Science, v. 24, p. 299-349.

Dagher, Z.R., and Boujaoude, S., 1997, Scientific views and religious beliefs of college students: The case of biological evolution, Journal of Research in Science Teaching. v. 34, p. 429-445.

Dawkins, R., 1976, The selfish gene, New York, Oxford University Press, 224 p.

Dawkins, R, 1998, The devil's chaplain: Reflections on hope, lies, science and love, Boston, MA, Houghton Mifflin 272 p.

Demastes, S.S., Settlage, J., and Good, R.G., 1995, Students' conceptual ecologies and the process of

conceptual change in evolution, Science Education, v. 79, p. 637-666.
Dennett, D.C., 1995, Darwin's dangerous idea: Evolution and the meanings of life, New York, Simon and Schuster, 586 p.
Farber, P.L., 1994, The temptations of evolutionary ethics, Berkeley, CA, University of California Press, 210 p.
Franklin, R.S., 1991, Shadows of race and class, Minneapolis, University of Minnesota Press, 189 p.
Genet, R. M., 1998, The epic of evolution: A course developmental project, Zygon, Journal of Religion and Science, v. 33, p. 635-644.
Gitt, W., 1995, Ten dangers of theistic evolution, Creation Magazine, v. 17, p. 49-51.
Griffith, J. A. and Brem, S.K., in press, The perceived impact of evolutionary theory: Implications for teacher education, Journal for Research in Science Teaching.
Gould, S.J., 1989, Wonderful life: the Burgess Shale and nature of history, New York, W.W. Norton, 347 p.
Guthrie, R.V., 1998, Even the rat was white, Needham Heights, Massachusetts, Allyn and Bacon, 282 p.
Ham, K., 1998, Evangelism for the new millennium, Creation Ex Nihilo, v. 20, p. 25-27.
Libarkin, J.C., Anderson, S.W., Dahl, J., Beilfuss, M., and Boone, W., 2005, Qualitative analysis of college students' ideas about the Earth: interviews and open-ended questionnaires, Journal of Geoscience Education, v. 53, p. 17-26.
McPhee, J., 1981, Basin and range: New York, Farrar, Straus, and Giroux, 216 p.
Moore, R., 1998-1999, Creationism in the United States (an 8-part series), American Biology Teacher, September-May.
Moreland, J.P., and Reynolds, J.M. Eds, 1999, Three views on creation and evolution, Grand Rapids, Michigan, Zondervan Publishing House, 304 p.
Palmer, A.R., 1989, The Earth has a history: Boulder, Colorado, Geological Society of America, Videotape EVS001, 20 minutes.
Piburn, M., Marr, F., and Allen, T., 1986, Alternative working hypotheses: A proposal for teaching about evolution and creationism, The Australian Science Teachers Journal. v. 32, p. 45-50.
Scott, E., 2000, The Creation/Evolution Continuum, National Center for Science Education, http://www.ncseweb.org (16 February, 2005).
Shankar, G. and Skoog, G.D., 1993, Emphasis given evolution and creationism by Texas high school biology teachers, Science Education, v. 77, p. 221-223.
Skoog, G., 1984, Evolution in textbooks, Science Education, v. 68, p. 117-128.
Smith, S.M., Ward, T.B., and Schumacher, J.S., 1993, Constraining effects of examples in a creative generation task, Memory and Cognition, v. 21, p. 837-845.
Suddendorf, T., and Corballis, M.C., 1997, Mental time travel and the evolution of the human mind, Genetic, Social and General Psychology Monographs, v. 123, p, 133-167.
Trend, R., 2000, Conceptions of geological time among primary teacher trainees, with reference to their engagement with geoscience, history, and science, International Journal of Science Education, v. 22, p. 539-555.
Ward, T.B., and Sifonis, S.M., 1997, Task demands and generative thinking: What changes and what remains the same?, Journal of Creative Behavior, v. 31, p. 245-259.
Wolpoff, M., and Caspari, R., 1997, Race and human evolution: A fatal attraction, New York, Simon and Schuster, 464 p.
Zen, E-an, 2001, What is deep time and why should anyone care, Journal of Geoscience Education, v. 49, p. 5-9.
Zimmerman, M., 1987, The evolution-creation controversy: Opinions of Ohio high school biology teachers, Ohio Journal of Science, v. 87, p. 115-125.