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## **Improvisational Drama and the Nature of Science: Using the Teaching of Origins as a Curriculum Issue to foster Epistemological Development**

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### ***Abstract***

Today's *Standards* call upon science teachers to help students construct viable conceptions of the nature of science, but many teachers and prospective teachers remain naive regarding significant epistemological issues related to the nature of science. Science teacher educators can simulate a 'real-world' situation that can serve as "construction zone" for their students' epistemological development. An improvisational drama focused on the evolution-creationism curriculum issue is offered, in which teacher education students place themselves in the shoes of a group of teachers, parents, and citizens in a school district about to become embroiled in a controversy over the teaching of evolution. Philosophical issues about the nature of science emerge or can be introduced to students following the role play. The simulation is modeled after a real-world (and on-going) Colorado case, which illustrates how contentious the teaching of origins can be as a science curriculum issue.

*Nothing in biology makes sense except in the light of evolution.*  
- Theodosius Dobzhansky (1973)

Nearly three-quarters of a century has passed since the famous trial of John Scopes in Tennessee, but how children should be taught about the origin of the physical and living universe still rears its head as an educational issue in many communities. In my own teaching experience I have often had to respond to complaints from parents and students about my presentations as a science teacher regarding evolution. The objectors have included students of all ages - middle and high school students (and some of their parents), undergraduate and graduate students in teacher preparation programs, and practicing teachers. Colleagues report anecdotally that the issue has surfaced in their own classrooms more often in recent years (Dennis Casey, personal communication, Nov. 10, 1997). The issue doesn't seem confined to the "Bible-belt," either. During a National Science Foundation-sponsored institute for biology teachers, when asked which topics were most troublesome teaching to students, *evolution* was listed as number one by the teacher-participants (Scharmann, 1994).

Creationism may have gotten a boost recently with the widespread publicity received by the 1996 publication of a book by biochemist Michael Behe, *Darwin's Black Box*. Behe argues that the "irreducible complexity" of the cell is inexplicable by Darwinian means and can only be explained by positing a 'designer.' Behe's argument has stimulated scathing and, to me, convincing responses from evolutionary biologists (Wheeler, 1996). For example, Allen Orr (1996) points out that,

To anyone paying attention over the last century, the revelation of complexity is no revelation at all. Geneticists, for instance, have known for sixty years that the modest fruit fly sports at least five thousand genes. So how could it not be complicated? You

don't need a script to know that a play featuring five thousand speaking parts is going to be a tad complicated.

Whether or not there is a resurgence of creationism in the country, recent national curriculum documents stand firmly behind evolution as the only scientific theory of origins to be taught to K-12 students (see for example, *Science for All Americans*, by the American Association for the Advancement of Science, 1989, and the *National Science Education Standards*, by the National Research Council, 1996). In teacher-preparation programs, the topic of the teaching of origins provides an opportunity for future teachers of science to express their own attitude on the issue. Teacher education students are likely to reflect the American population as a whole, in which many people still find the teaching of origins in the schools to be a controversial issue (Hill, 1996; Ruse, 1989). Participation in the improvisation activity draws upon both students' scientific knowledge and knowledge about the nature of science. As a consequence of grappling with the evolution-creationist curriculum issue, aspiring and practicing teachers may further develop their own understanding of key philosophical issues regarding the nature of science. One philosophical issue related to the evolution-creationist curriculum issue, for instance, is that of *demarcation*. In the dramatization, the actors deliberate with each other over demarcation criteria, trying to draw a line between what counts as *scientific* and what doesn't.

As a science teacher educator, I want to help my students construct warranted conceptions of the nature of science. One of my major goals is that the course experiences contribute to my students' *epistemological development*, an aspect of education Rosalind Driver (1994, p. 219) has identified as being sorely lacking in typical schooling.

Traditional curriculum and instruction in the sciences apparently has not done well in communicating anything but a shallow notion of the nature of science to students (Meichtry, 1993; Duschl, 1989, Duschl & Hamilton, 1993, Lederman, 1992), and many aspiring science teachers arrive in their teacher education courses as unexamined positivists, holding significant unwarranted conceptions about science (and technology) (Bentley & Fleury, 1998). Future teachers of science cannot be expected to help their own students move beyond misconceptions and stereotypes to develop warranted conceptions of the nature of science unless they first struggle with understanding of some of the philosophical issues involved themselves (Bentley & Garrison, 1991; Fleury & Bentley, 1991; Garrison & Bentley, 1990).

What I offer here is a classroom improvisational drama activity that has the potential to engage aspiring or practicing teachers in deliberating about epistemological issues as they play act their roles in a hypothetical but realistic situation set in a school district where parents have objected to the teaching of evolution.<sup>1</sup> The simulation/improvisation provides an opportunity for science teacher education students not only to apply what they know from several science fields, but also to perceive a curriculum issue from a different perspective and to consider and interact spontaneously with each others' points of view.

#### The teaching of origins as a contentious curriculum issue

The simulation below is not unlike the situation related to the teaching of origins that arose in the Jefferson County school district outside Denver in 1996. Danny Phillips, a tenth grader and straight-A student lodged a formal protest against his school's science curriculum, objecting to curriculum materials used in his biology class, that, in his view, taught evolution "as fact."

Phillips objected to the *Miracle of Life* video by Swedish photographer Lennart Nilsson, a NOVA episode which is seen annually by thousands of middle and high school students all over the world.<sup>2</sup> On the form, “Citizen’s Request for Reconsideration of Learning/Human Resources,” Phillips complained that the message about the origin of life in the video conflicted with his beliefs as a member of the Church of the Nazarene. He lodged the same complaint about his biology textbook, *Biological Science: An Ecological Approach* (commonly known as BSCS Green).

After the district’s curriculum review panel examined the curriculum materials in question and met with Phillips, it refused to withdraw the biology textbook, but recommended to the district superintendent three possible solutions: (1) instruct the life science teachers to show the video without the offending comments (which are in the film’s introduction), (2) ask the video’s producers to supply a modified version, or (3) tell teachers to select an alternative video. The superintendent went along with the recommendation, but the district’s science teachers reacted strongly to the censoring of the resource. The teachers proposed, instead, that a guide for use of the video be written that would advise teachers: “Be sure to have students look at specific points from both scientific and nonscientific perspectives.” (Hill, 1996, p. 31)

After the media caught wind of the dispute and made Danny Phillips a local celebrity, citizens packed the next School Board meeting. However, most of those who voiced an opinion at the meeting favored *keeping* the video. Consequently, the Board put off its decision. Meanwhile, Joseph McInerney, the director of BSCS, published a letter in the *Denver Post* which accused the district of giving in “to ignorance and intimidation at the hands of the religious right.” (Hill, 1996, p 31)

The next Board meeting was packed again, and Phillips was there with a lawyer. The *Miracle of Life* video was shown and many citizens spoke. One Board member finally endorsed the teachers' idea of a guide (but wanted its use to be mandatory). Another member argued that such interference in the curriculum would set a bad precedent and would restrict the academic freedom of the science teachers. The Jefferson County School Board ultimately voted 3-1 to overrule the superintendent and reinstate the video, but the matter is not settled as this is being written. The superintendent has resigned and Danny Phillips, now a senior, still regularly attends Board meetings, seeking to have the video and textbook suppressed (Jefferson County Schools, personal communication, November 20, 1997).

The simulation/improvisation situation below also reflects events in other places where the teaching of origins has been a contentious curriculum issue in recent times.<sup>3</sup> In 1994, the Tangipahoa Parish, Louisiana school board adopted a policy indicating that the teaching of evolution in the curriculum was *not* for the purpose of influencing or dissuading students from belief in the Biblical version of Creation. In 1995 the Alabama State Board of Education voted to put a disclaimer in biology textbooks across the state stating that evolution is 'controversial' and accepted by 'some scientists' (see Box, Alabama Insert, below). In Georgia, after a complaint by the Cobb County science textbook committee, Macmillan/McGraw Hill agreed to delete from a fourth grade science textbook the chapter entitled "The birth of Earth" because it did not include creation as an alternative theory of origin. In Marshall County, Kentucky in 1996 school officials ordered that the district's fifth and sixth grade science textbooks be collected so that two pages dealing with the Big Bang theory of the origin of the universe could be glued together. Also in 1996, in Clayton County, Georgia, the school board voted to adopt

the language of Alabama's disclaimer on evolution (the Alabama Insert) and paste it to the cover of the district's 140,000 science textbooks (Hill, 1996).

### The Alabama Insert

#### A MESSAGE FROM THE ALABAMA STATE BOARD OF EDUCATION

This textbook discusses evolution, a controversial theory some scientists present as a scientific explanation for the origin of living things, such as plants, animals and humans. No one was present when life first appeared on earth. Therefore, any statement about life's origins should be considered as theory, not fact.

The word "evolution" may refer to many types of change. Evolution describes changes that occur within a species. (White moths, for example, may "evolve" into gray moths.) This process is microevolution, which can be observed and described as fact. Evolution may also refer to the change of one living thing to another, such as reptiles into birds. This process, called macroevolution, has never been observed and should be considered a theory. Evolution also refers to the unproven belief that random, undirected forces produced a world of living things.

There are many unanswered questions about the origin of life which are not mentioned in your textbooks, including:

Why did the major groups of animals suddenly appear in the fossil record (known as the Cambrian Explosion)?

Why have no new major groups of living things appeared in the fossil record in a long time?

Why do major groups of plants and animals have no transitional forms in the fossil record?

How did you and all living things come to possess such a complete and complex set of "instructions" for building a living body?

Study hard and keep an open mind. Someday you may contribute to the theories of how living things appeared on earth. (Anderson, 1996)

Some background on the teaching of origins as a curriculum issue

In 1925 science teacher John Scopes was convicted of teaching Darwin's theory of evolution in the famous Dayton, Tennessee "monkey trial," but the verdict was later overturned on a technicality. The public response to the case convinced the press (and textbook publishers) that the average American did *not* approve of evolution. Consequently, evolution, biology's central organizing theory, gradually disappeared from middle and high school life science textbooks and other curriculum materials (Hill, 1996). However, in the 1960s biologists led the NSF funded writing teams for the BSCS textbooks to once again portray Darwinian evolution in a way that acknowledges the theory's central, organizing role in the discipline.

The separation of church and state.

The courts have consistently excluded creationism from the public school science curriculum on First Amendment grounds. The U.S. Supreme Court ruled on the matter in two landmark cases. In 1968, in *Epperson v. Arkansas*, the Court struck down an Arkansas law banning the teaching of evolution. Then in 1982, Louisiana passed a law requiring that any public school teaching evolution give equal time to the theory of 'creation science.' Don Aguillard, a biology teacher, challenged the law, and, in *Edwards v. Aguillard*, the Court ruled the Louisiana law violated the First Amendment's establishment clause and was unconstitutional. Notably, the Court added that, "teaching a variety of scientific theories about the origins of mankind to schoolchildren might be done with the clear secular intent of enhancing the effectiveness of science instruction." (Hill, 1996, p. 30)<sup>4</sup>

Since their defeat in the courts, anti-evolutionists now argue that evolution must be taught as a *theory*, not as a fact, and that students should be provided the evidence against

evolution. Major centers of anti-evolution activity include Henry Morris' Institute for Creation Research in San Diego and the Foundation for Thought and Ethics in Texas (representative publications are cited in Appendix C.<sup>5</sup>

A classroom activity to introduce issues about the nature of science

The following simulation/improvisation activity was designed for my own science education students and has been modified several times based on classroom experience. The activity is also adaptable for in-service workshops. The teaching purpose is to provide an opportunity for science education students to develop a more sophisticated understanding both of a specific curriculum issue and issues related to the nature of science. In the improvisation, students act out the roles of teachers, parents, and community leaders in responding to parents' objections that evolution, as taught in the school curriculum, conflicts with their religious beliefs.

In the dramatization, instead of having a single student assigned to an acting role, students "play" their roles as cooperative groups. Depending on the class size, two or more students are assigned to a team for each role. The team then chooses which team member will actually act the part. Before the enactment, the actor team deliberates the issues and plans a response to the situation (a list of guiding questions are given to each actor team, see below). Thus each actor team commits to a stance on various aspects of the issue before the play begins. Once underway, each actor spontaneously plays out his/her understanding of the stance.

As a practical matter, the duration of the play has to be limited to the class time available. Success, however, depends upon adequate time for students to deliberate their

team's part, and for time for the debriefing. Students need an opportunity to reflect upon and discuss what happened 'on-stage,' especially the recommendation the 'Science Committee' finally agrees to forward to the imaginary 'Rhonda McElvoy, district Assistant Superintendent for Curriculum and Instruction' (see Appendix A). Following the dramatization and discussion epistemological issues about the nature of science can be identified and further discussed.

### *The Classroom Drama*

#### The Setting:

A meeting of the district Science Curriculum Committee, in classroom of the Chairperson of district's Science Curriculum Committee. Chris, the Chairperson, opens by sharing a memo sent from the Assistant Superintendent (Appendix A). Community representatives are present who have been invited to present their views on the issue to the Committee. After these guests state their positions and leave, Chris leads the Committee in a discussion of the issues. Chris' job is to get the Committee to reach a consensus on the teaching of origins in the science program. From the consensus reached, Chris must draft a position statement to send to the District Office.

#### The Parts:

- Chris - Chairperson of district's Science Curriculum Committee, life science teacher, strong biology and chemistry background, single parent of an adolescent son, interested in environmental preservation, active member of mainstream church;
- Mickey - veteran physical science teacher from a family of engineers, parent of two college students, served in the military, pro-nuclear power, non-church goer, considered "tough" by students but respected because s/he also serves as a coach;
- Sandy - earth science/general science teacher, single/never married, former "60s-person", popular with students, leader of annual Earth Week activities, an agnostic who opposes organized religion;
- Cam - has taught fifth grade for five years, married with a four year old daughter, non-practicing Jew, member of the ACLU, active in the teacher's union, technology buff, helped initiate the movement to create the local science museum;
- Jo(e) - left a law career to become a teacher after a mid-life crisis, now in third year as life and physical science teacher, divorced, no children, sister an anthropologist.

- Alex - the principal of the middle school. Not a committee member but periodically sits in on meetings - coached soccer and taught middle school life science before earning a degree in school administration, hates controversy.
- Cary (Carrie) - parent of sixth grade student in district, member of Church of the Nazarene, was among several parents who complained about evolution at the Board meeting; works as a chemist at the city's water treatment plant;
- The Rev. Pat M. - local Roman Catholic priest.
- The Rev. Terry B. - minister of an independent evangelical church, formerly associated with the Southern Baptist Convention.

Guiding questions for each team to deliberate in order to determine the actor's stance:

- What should the district's children be taught in their science classes about origins (of the universe, the world, life, humans...)?
- Is evolution a scientific *fact* or *theory*? Or both? What does *theory* mean in science?
- Are there *real* conflicts between science and religion? Is this one?
- What is the Constitution's First Amendment prohibition on the establishment of religion and is it relevant here?
- How should the school and district respond to those whose religious beliefs are in conflict with the curriculum?
- How should such conflicts in the community be explained to students?

### The Debriefing

After the play, adequate time should be allotted for students to reflect on the process of negotiation that took place in the dramatization and the final decision (the recommendation to be sent to the administrator). Students are likely to identify some philosophical issues themselves, which include demarcation, what counts as evidence in science, and the nature of authority in science. Educational issues are likely to arise as well, such as the respective roles of the local community and the disciplinary (scientific) community in determining the school

curriculum. Also, students should consider how the controversy relates to the ideal that students be educated to become competent social actors in a democracy (Larochele, & Desautels, 1991).

To L. C. Sharmann (1994), the reason evolution continues to be a contentious curriculum issue is because many people harbor various misconceptions about the nature of science, specifically regarding the *role of theory* in science (see also, Duschl, 1989). Many interpret the term theory to mean a speculative idea, similar to a hypothesis, rather than as a complex set of interconnected statements that makes up the best *explanation* about the natural phenomena. Also, some people see the world in dichotomous or dualistic terms and are likely to see the theory of evolution and creationism as polar opposites.

According to Sharmann, science teachers typically take one of two approaches in dealing with evolution in the curriculum. The first is to ignore any resistance from students and present evolution as a fact. The second is to side step student resistance by avoiding the use of the term *evolution*, for example, by discussing *adaptation* while leaving out any ideas about the natural mechanisms that produce it.

The first approach is hard on the students who perceive evolution to be in conflict with their personal beliefs. The teacher ultimately puts such students in the position of making a “forced choice.” The second approach may be less troubling for conflicted students, but it “avoids opportunities for students to resolve personal conflict, find common ground among peers and develop a tolerance for different viewpoints.” (Sharmann, 1994, p. 125) If teachers follow this approach, students not only retain their initial views, they fail to see the organizing role evolution plays in the earth-space and life sciences.

Sharmann suggests a third approach, that science teachers focus on *readiness*. “The aim...is ...to enhance a student’s ability to take the next logical step towards thinking in a manner more similar to that of the practicing scientist.” (p. 125) The kinds of teaching strategies that increase opportunities for students’ conceptual development include,

1. Providing opportunities for students to express their initial ideas,
2. Encouraging student-to-student interaction,
3. Facilitating teacher-to-student interaction,
4. Providing opportunities for students to express themselves in a reflective manner (Sharmann, 1994).

Teachers might develop students readiness by engaging them in reading and discussing accessible articles illustrating the explanatory power of evolutionary theory. For instance, Stephen Jay Gould’s (1987) flamingo’s ‘smile’ essay and the one on the Irish elk in *Ever since Darwin* (1977) are both accessible to high school students and show how specific animal characteristics make sense from an evolutionary perspective.

#### Indoctrination and ‘warranted assertability’

Those who advocate laws mandating the inclusion of creationism whenever evolution is taught argue that teaching evolution alone amounts to indoctrination. However, part of education actually *is* indoctrinating, and necessarily so. Long ago St. Anselm recognized the relation of believing to understanding (*credo ut intelligam*). While some level of indoctrination is required at the level of initial science learning, teachers ultimately should get around to discussing with students what counts as evidence in science. The issue is what kind and amount of evidence provides for “warranted assertability” (in Dewey’s sense) regarding a

theory of origins. Appendix B contains a list of questions about evolution, creationism, and their role in the curriculum that might be used in debriefing the classroom improvisation or in otherwise addressing this issue. Additional curriculum materials/resources on the issue of evolution, creationism, and the curriculum are listed in Appendix C.

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Appendix A: Dramatization prop: Memo from the School Administration

Moonview Public Schools  
6543 Carambola Blvd., Moonview, Virginia 20401

***MEMORANDUM***

TO: Chris Rhodes, Science Department Chair, Moonview Middle School

FROM: Rhonda McElvoy, Assistant Superintendent for Curriculum and Instruction

DATE: 2/15/98

RE: School Board Request for Information on Science Program

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Chris: If you read yesterday's Pioneer Press coverage of last week's School Board meeting, you know that several parents brought up the issue of the teaching of evolution in our science classes. The Superintendent has asked me to prepare information for the Board about evolution in our science program. I must rely on you in this regard since my background is not in science and I, too, need to be updated on what we are teaching in this area and what is most appropriate. The parents complained that their children are being taught the Big Bang and the evolution of life, but that other views of the origin of the universe and life are not discussed. Is this the case? These parents want a balanced curriculum.

I would like to know what the faculty think on how we should respond to this group of parents. Please describe for me briefly the approach being taken in our science program. Do you feel our curriculum should provide a forum for alternative views? Please give me some reasons supporting your recommendation on this - we expect inquiries from the press. Chris, I'm sorry to drop this on you on such short notice, but the Board and my office were surprised by the situation. I need something by the end of the week. Thanks!

Appendix B: Debriefing prop: Questions about Evolution, Creationism, and the Curriculum

Questions related to the Teaching of Origins

1. Many religions and Western science offer explanations about origins (of the universe, of life, of humankind). Are these explanations compatible, or are they at odds? Explain your view.
2. Theology and biology are both scholarly disciplines. How are the research methods used in each field alike? different?
3. Is evolution a *directed* or *random* process? Can this question be answered scientifically?
4. Biologically, what is the relationship of humans to other species. Is *Homo sapiens* in any sense the “end point” of evolution?
5. Is there any “alpha point” or beginning in evolution? Is there any “omega point?”
6. At what point might “soul” have entered the history of life? Should this be a question for scientists?
7. How would a special creationist explain the various types of evidences for evolution (such as fossils, genetic and embryological similarities, homologous structures, etc.)?
8. Can the theory of design, or “special creation” be investigated via currently available scientific methods?
9. Should life science curriculum materials in the public schools be required to include the theory of special creation? If so, which particular aspects of creationism should be included?
10. What is “cultural evolution?” How does it affect biological evolution?
11. What is “fitness” in an evolutionary sense? How are fitness and selection related?
12. How should evolution be presented to students, for example, as a ‘fact’ or ‘theory?’
13. Have humans descended from apes? If so, how? If not, from what did humans evolve?
14. Do you think the genetic manipulation of somatic and germ cell DNA by scientists could affect the gene pools of future generations? Should this be a public concern?
15. Should citizens be concerned about the genetic manipulation of plants and animals? Do these manipulations have any influence on the evolution of the species involved?
16. Would the manipulation of human somatic and/or germ cells influence the process of human evolution? Explain. (adapted from Kurvink, 1995)

Appendix C: Additional Resources on Evolution, Creationism, and the Curriculum

**Creationist books**

Behe, M. (1996). Darwin's black box: The biochemical challenge to evolution. New York: Free Press.

Bird, W. (1989). The origin of species revisited. New York: Philosophical Library. (2 volumes)

Buell, J. & Hearn, V. (Ed.). (1994). Darwinism: Science or philosophy? Richardson, TX: Foundation for Thought and Ethics.

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Moreland, J. P. (Ed.). (1994). The creation hypothesis. Downer's Grove: IL.

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**Books on Evolution**

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### **Books on Darwinism and Religion**

- Lindberg, D. & Numbers, R. (Eds.). (1986). God and nature: Historical essays on the encounter between Christianity and science. Berkeley: University of California Press.
- Moreland, J. P. (1989). Christianity and the nature of science. Grand Rapids, Mich.: Baker Book House.

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<sup>1</sup>A similar activity is described in Bentley & Fleury, 1998.

<sup>2</sup>Nilsson won fame in 1965 with a photo essay published in *Life* that showed a living human fetus inside the womb (the photo is frequently cited as one of two consciousness-raising icons of the Twentieth Century, the other being NASA's picture of the Earth from space). Nilsson's 1983 Emmy Award-winning NOVA documentary, *Miracle of Life*, took eighteen years to complete and shows sexual reproduction deep within the body. His *Odyssey of Life* premiered as a NOVA episode in 1996.

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<sup>3</sup>David Hill's extensive article on the issue can be accessed from Education Week's home page, < <http://www.edweek.org> >. The same story was reported in Teacher Magazine, November-December issue, 1996, pp. 22-27.

<sup>4</sup>William. Brennan Jr wrote for the Court while Antonia Scalia dissented.

<sup>5</sup>The latter has produced the textbook, *Of Pandas and People: The Central Question of Biological Origins*, by Percival Davis and Dean Kenyon.