Shaw, Sam

From: Bob Lattimer <info@copeinc.org>
Sent: Monday, May 11, 2015 9:19 PM
To: Shaw, Sam
Subject: South Dakota science standards revision.
Attachments: SoDakotaMay2015.docx

Mr. Shaw,
Attached are some extended comments on the revised South Dakota Science Standards. The main problem is that the standards, based on NGSS, promote a materialistic worldview – particularly in historical origins science. Several performance expectations should be revised to reflect scientific objectivity and religious neutrality.
Robert Lattimer, Ph.D.
President, Citizens for Objective Public Education (COPE)
www.COPEinc.org
info@COPEinc.org

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Proposed South Dakota Science Standards (*SDSS*) - 2015

South Dakota is considering new science standards for possible adoption in 2015. The following comments are offered for consideration:

1. The *SDSS* Preface states that the proposed standards were "guided" by "the existing South Dakota Content Standards, the progression of recently published standards from Massachusetts and South Dakota, the Next Generation Science Standards [NGSS] document, the National Research Council's Framework for K-12 Science Education, and lengthy discussions by experienced kindergarten through grade sixteen South Dakota educators."

2. Both the Middle School and High School proposed standards for Life Science and Earth and Space Science have been examined. Interestingly, *all* of the performance expectations (PEs or "standards") are essentially the same as those in *NGSS*. A few of the *NGSS* PEs have been slightly modified, and a small number have been omitted. The South Dakota Workgroup has not added any additional state-developed PEs (at least on the above topics).

3. *SDSS* uses the *NGSS* performance expectations and omits most of the ancillary *NGSS* material. Specifically, the *NGSS* front matter, introductory sections, Clarification Statements, and Appendices are omitted. Scientific and Engineering Practices (SEP), Crosscutting Concepts (CCC), and Disciplinary Core Ideas (DCI) have been greatly condensed. South Dakota has written its own Preface, as well as brief Core Ideas and Conceptual Understanding introductions for each section.

5. Most of the performance expectations are acceptable. The ones listed below are unsatisfactory due to (a) lack of scientific accuracy (including omission of pertinent scientific evidence), (b) age-inappropriateness (teaching origins science before high school), and/or (c) use of methodological naturalism (the assumption that all explanations in science must be materialistic/naturalistic in nature).

MIDDLE SCHOOL LIFE SCIENCE.
First, it is strongly recommend that instruction in *biological evolution* be delayed until high school biology. Students in elementary and middle school do not have the science background or the intellectual maturity to objectively examine complex issues in origins science. Specifically, MS-LS3-1, MS-LS4-1, MS-LS4-2 should be moved into High School Life Science.

NOTE that (except where noted) the South Dakota PEs have the same labels as the corresponding standards in *NGSS*.

MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

*The standard is misleading. It should inform students (a) that genetic mutations are almost always harmful or neutral, (b) that accumulation of mutations leads to a lack of fitness of the

organism (genetic entropy), (c) that mutational variation is a key part of the neo-Darwinian mechanism for macroevolution (common descent), and (d) that it is questionable whether this mechanism can provide the variation needed for entirely new species (new body parts and body plans).

MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth. Note that *SDSS* eliminates the final clause in the *NGSS* version: "... under the assumption that natural laws operate today as in the past."

*This PE is good in that it is open-ended regarding analysis of the fossil record. However, since the standards overall are materialistic, the presumed intent of the PE is for students to arrive at common descent as the proper explanation for the fossil record. Students should compare *both* materialistic (unguided evolution) and teleological (purposeful design) explanations of the fossil record. The general pattern of the fossil record is sudden appearance of new species, stasis during their time on earth, extinction, and lack of transition fossils between species. This is more consistent with the pattern one would expect from teleology (intentional design) that from neo-Darwinian evolution.

MS-LS4-2. Apply scientific ideas to construct an explanation for the similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. Note that *SDSS* eliminates the word "anatomical," which appears before "similarities" in the *NGSS* version.

*This is deceiving since it *assumes* evolutionary relationships exist among organisms. Students should compare both materialistic (unguided evolution) and teleological (purposeful design) explanations for similarities. The main point is that similarities (homologies) could be due to either common ancestry or common design.

MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

MS-LS4-5. Obtain, evaluate, and communicate information about how technological advances have changed the way humans influence the inheritance of desired traits in organisms. Note that the *NGSS* version begins "Gather and synthesize information about the technologies that have changed...."

MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

*None of these seems objectionable; they all involve microevolutionary processes. These PEs should be listed together as part of a section on microevolution (adaptation; small-scale change within a species). Students should know that the mechanisms for microevolution are different than those proposed for macroevolution (common descent). That is, the variation needed for microevolution is *already present* in the gene pool, while the variation needed for macroevolution is proposed to arise via genetic mutations.

MIDDLE SCHOOL EARTH AND SPACE SCIENCE.

This section contains performance expectations related to environmental science, which is not covered as a separate discipline in *NGSS*. Aspects of the subject are included in Earth and Space Science and Life Science.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

*These PEs emphasize *negative* effects of human activity on the environment. A PE should be added that stresses positive effects and good stewardship of the Earth; *e.g.*, reuse and recycling of materials, pollution control, water purification, habitat development, protection of endangered species, pest/disease control, reforestation, fuel efficiency improvement, agricultural production improvement, and responsible waste disposal.

MS-ESS3-5. Ask questions to clarify evidence of the factors that may have caused a change in global temperatures over the past century. Note that the *NGSS* version reads "... clarify evidence of the factors that have caused the rise in global temperatures...."

*This PE that deals with "climate change." The South Dakota revision is better than the *NGSS* version, but it still needs improvement. Temperatures have both risen and fallen during Earth's long history, and the standard should cover the past several centuries (not just 100 years). Also, important factors in climate change should be specifically listed; *e.g.*, variations in solar radiation, volcanic eruptions, large meteorite impacts, natural wildfires, and the burning of fossil fuels. Students should know that global temperatures follow a cyclic pattern that is closely related to changes in solar radiation. It is not known whether fossil fuel combustion is a significant contributor to recent global warming; students should study the evidence objectively.

HIGH SCHOOL LIFE SCIENCE.

This section deals with *biological evolution* (descent with modification from a common ancestry), which is part of *origins science* (the study of the origin and development of the universe, of life, and of life's diversity). Origins science is a *historical science*, for which the method of inquiry is different than in *operational* (present-day) *science*. Due to the complex and controversial nature of origins science, it is recommended that new performance expectations be added at the beginning of this section to introduce historical science, methodological naturalism, materialism/teleology, and different meanings of biological evolution.

Students should know the following information:

1. *Operational* or experimental sciences (like chemistry, physics, and descriptive biology) study phenomena that are subject to *experimentation* and *observation* in today's world. *Historical* sciences (like cosmology, historical geology, archaeology, and origins science) study phenomena that occurred in the distant past; these events cannot be replicated or observed in the present-day

world. In operational science, inquiry using the *scientific method* generally involves (a) the recognition of a phenomenon or problem in nature, (b) the formation of a hypothesis (possible explanation), (c) testing the hypothesis by experiment and/or observation, and (d) drawing conclusions regarding the hypothesis.

2. Explanations in the *historical* sciences are more *tentative* than those in operational sciences, since the phenomena cannot be duplicated in today's world. Inquiry in historical science uses the method of *multiple competing hypotheses*. This involves (a) selecting a historical phenomenon/event, (b) developing competing hypotheses to explain the phenomenon, and (c) selecting the hypothesis (narrative) that best explains the data.

3. *Methodological naturalism* (MN or scientific materialism) is the doctrine that science is not permitted to explain the cause of events in the natural world with anything other than a materialistic or naturalistic explanation (*i.e.*, by natural laws and chance). MN is used to exclude the competing explanation in origins (*i.e.*, teleology). While the use of MN is generally appropriate in operational science, MN should *not* be used in historical sciences because past events are *singular* (*i.e.*, unique one-time events that cannot be replicated).

4. *Materialism* (or naturalism) is the philosophy that physical matter/energy is the only reality and the reality through which all existence and phenomena can be explained. *Teleology* is the study of design or purpose in nature. Materialism posits that there is no supernatural aspect to reality, while teleology considers the possibility of intentional design in nature by an intelligent agent – who most people would identify as God. Since historical events cannot be replicated, possible explanations for phenomena in the past should include both materialistic and teleological hypotheses.

5. The term *biological evolution* has multiple meanings; *e.g.*, change over time, microevolution, macroevolution, and neo-Darwinian mechanism. *Change over time* indicates that the variety of lifeforms on earth has differed over geologic time. *Microevolution* is small-scale change within a population; it is also referred to as *adaptation* or a *change in gene frequencies*. *Macroevolution* is large-scale change leading over time to novel body parts and body plans, and new species; it is also referred to as *descent with modification from a common ancestry, common descent*, or *Darwinian evolution*. The *Neo-Darwinian mechanism* is the proposed process by which macroevolution occurs; *i.e.*, variation by DNA mutation followed by natural selection. Micro- and macroevolution should be distinguished since the definitions and proposed mechanisms of change are different.

6. The *origin of life on Earth* is not covered by either *NGSS* or *SDSS*. This is likely due to the fact that the origin of life is a mystery with many unanswered questions, and at present there is no viable materialistic explanation. This is an important topic in origins, however, and students should evaluate various hypotheses, both materialistic (chemical evolution) and teleological (intentional design) for the origin of life. Chemical evolution scenarios include the Oparin-Haldane primordial soup, Cairns-Smith clay hypothesis, deep-sea vent, and panspermia. Unanswered questions pointing to teleology include the abiotic synthesis of complex biological molecules, the origin of information in DNA and the genetic code, and the assembly of components into the first living cell.

NOTE. It is recommended that Middle School PEs for macroevolution be transferred to this section (MS-LS4-1 and MS-LS4-2).

HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

*This PE is biased since it *assumes* that biological evolution (macroevolution) took place. Lines of evidence can, in fact, be interpreted in terms of either evolution (common descent) or teleology (intentional design). Also, the lines of evidence should be specified; *e.g.*, fossil record, anatomical similarities (homologies), biogeographical distribution, and embryological development

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

*The question here is what is meant by "evolution." In item #2 the word "mutation" indicates the intent is macroevolution (common descent). *Mutations* are generally not involved in microevolution. This PE needs to specify whether it relates to microevolution or macroevolution; the mechanisms for the two are different.

A major problem with the standards is they never distinguish between microevolution and macroevolution and the different mechanisms for each. The main difference is that the variation for microevolution occurs naturally in the gene pool, while the variation in macroevolution is proposed to occur via DNA mutations. The difficulty with the neo-Darwinian mechanism for macroevolution is that almost all DNA mutations are either harmful or neutral in their effect, and accumulated mutations result in a loss of fitness of the species – and eventual extinction. Rare "beneficial" mutations may help the organism combat specific environmental threats, but when the threat subsides the beneficial mutations decrease in their frequency in the gene pool. It is not appropriate to extrapolate microevolutionary processes to explain macroevolution; the mechanisms are different.

HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

*These describe microevolutionary processes. No modification is needed, but the PEs should state that they relate to microevolution.

HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

*This intent of this PE is unclear. On one hand it seems to mix micro- and macroevolution. If microevolution is intended, then the word "species" in #2 should be changed to "varieties" – a *variety* being a category within a species based on some hereditary difference. The "emergence" of a species could imply either macroevolution or teleology (intentional design), depending on one's point of view. In short, clarification is needed.

HS-LS4-6. Use a simulation to research and analyze possible solutions for the adverse impacts of human activity on biodiversity. Note that the *NGSS* version begins: "Create or revise a simulation to test a solution to mitigate adverse impacts...."

*This PE doesn't seem to relate much to "biological evolution." The PE reads rather negatively. Human activity could have beneficial impacts (not just adverse ones) to biodiversity.

HS-LS4-7. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. Note that *NGSS* lists this PE in Middle School Life Science (MS-LS-3), and *SDSS* moves it to High School – which is the proper place.

*This is another PE that needs clarification. It is probable that *evolutionary relationships* are intended, but this assumes that such relationships exist. Embryological development at one time was considered to be a strong line of evidence for macroevolution. However, in recent years it has been found that different genes can give rise to similar structures, and similar genes can give rise to dissimilar structures. Also, embryos of one species are different from those of "related" species at all stages of development. This evidence suggests that similar species may not have evolutionary relationships (common ancestors).

HIGH SCHOOL EARTH AND SPACE SCIENCE.

HS-ESS1-2. Construct an explanation of the Big Bang Theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

*This is the only PE dealing with the *origin of the universe* (cosmology). Since this is an important topic in origins science, the coverage should be expanded to include these factors:
1. The *cosmic background radiation* should be added as additional evidence for the Big Bang.
2. The Big Bang implies a *beginning* to the universe. Students should compare the evidence for a beginning to that for an eternal universe. There appears to be little evidence for a universe without a beginning; the "steady state" and "oscillating universe" hypotheses are no longer favored, and the law of entropy argues against an eternal universe. On the other hand, a universe with a beginning implies that there was a "beginner" (or designer, a non-material entity).
3. The *fundamental physical constants* of the universe appear to be *fine-tuned* for the development of intelligent life (the Anthropic Principle). That is, physical constants must have very precise values in order for the universe to exist in its observed form and to provide conditions suitable for the development of life. The *multiple universe* (or multiverse) hypothesis posits that there are many (perhaps an infinite number) of universes with differing physical constants, and that we happen to live in a universe that is conducive to the development of life.

A difficulty with the hypothesis is that multiple universes cannot be observed; therefore it is questionable that this idea lies within the realm of science.

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

*This PE seems appropriate. "Mineral resources" include some fossil fuels, but there is really nothing in the standards about current and future energy sources. A new PE should be added that objectively compares nonrenewable and renewable energy sources.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

*These tend to emphasize *negative* impacts of human activities. A PE should be added that lists examples of how human activities can show responsible stewardship of the environment; *e.g.*, reuse and recycling of materials, pollution control, water purification, habitat development, protection of endangered species, pest/disease control, reforestation, fuel efficiency improvement, agricultural production improvement, and responsible waste disposal.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

*This expectation seems designed to highlight computerized climate models that predict catastrophic global warning. The subject must be presented from an objective viewpoint to show that the science is uncertain and there are differing opinions on the issue. Students should evaluate the assumptions used and the differing results obtained from global climate models.

Robert Lattimer, Ph.D.
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