

The OHIO ACADEMY of SCIENCE

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Fostering curiosity, discovery and innovation to benefit society.

Testimony of
Mr. Lynn E. Elfner, CEO
The Ohio Academy of Science
Prepared for delivery to
The Ohio Board of Education
June 7, 2010

on the draft
Ohio Science Education Standards
under consideration by the
Ohio Board of Education

Educational Service Center of Central Ohio
2080 Citygate Drive
Columbus OH 43219

Summary

The draft science education standards fall flat and are less effective than the 2002 standards because they avoid content on the nature and workings of contemporary science and are silent on technology and technological design. The draft standards are characterized best as "skill-less" with little fidelity to the skill sets articulated in Am. Sub. H.B. 1. We urge the adoption of the attached pro forma amendment to include technological design in parallel with scientific inquiry.

President Cain, Vice President Womer Benjamin, members of the Board, Supt. Delisle. Staff.

My name is Lynn Elfner and I serve as the CEO of The Ohio Academy of Science.

Founded in 1891, the Academy fosters curiosity, discovery and innovation to benefit society.

Thank you for allowing me to summarize our concerns that the draft Ohio Science Education Standards under consideration by the Ohio Board of Education fail to meet the stringent skill set requirements of Am. Sub. H.B. 1.

Skills required but missing

That bill distinguishes between academic content standards and model curricula and specifies that standards articulate skills and not just statements of the subject.

We welcome the massive reduction in the detailed content of the 311 page 2002 standards vs. the now condensed Overview, PK-8 draft standards and high school model syllabi. Strict adherence to the clear, simplified goals, definitions and robust philosophies in the Overview could thrust Ohio to the forefront of state standards and foreshadow the content of the National science education standards due in two years.

However, beyond the Overview, the draft standards fall flat and are less effective than the 2002 standards because they avoid content on the nature and workings of contemporary science and are silent on technology and technological design. In the triage to reduce the 2002 content, concepts central to understanding the nature of science were lost in favor of expressing isolated statements, referred to by at least one National reviewer, as factoids.

The essential way science works is gone.

Having written key components of the text in the Overview, we generally agree with the overall vision and direction. The central issue for the Academy, however, is the fact that the ODE staff and some members of The State Board of Education continue to promise to meet our concerns “sometime in the future” in what surely will be a massive, unwieldy, online, curriculum document that most of Ohio’s teachers will ignore. Indeed, Am. Sub. H.B. 1 is clear that schools, in fact, may ignore model curricula.

Science as a way of knowing and learning about the natural world should far outweigh learning any statement expressed as principles, theories, concepts or laws. Technological design—the heart of a modern economy—is missing. We see nothing to excite students like fuel cells, nanotechnology, “green” or alternative energy and technology, biotechnology, liquid crystals, polymers, creativity, innovation and entrepreneurial ideas.

No connection with economic development

The draft standards are sanitized, sterile and have no obvious connection to economic development, jobs, progress or the quality of life Ohioans should gain from a robust science education. The draft science education standards will not allow each student to be prepared for postsecondary instruction and the workplace for success in the twenty-first century as required by Am. Sub. H.B. 1.

Also missing are the interconnected and interdependent nature of contemporary science, technology, engineering and mathematics that demands focus on cross-curricular (especially from English and mathematics), problem-solving and communications skills, and real-world applications required by Am. Sub. H.B. 1.

Most 21st Century Skills are also absent.

Students gain lifetime benefits from the habits of mind—such as skepticism—acquired by understanding the nature of science. The skill-less nature of the draft standards manifests itself also in freshmen college students in Ohio, many of whom are skill-less as noted by Ohio college professors who teach introductory STEM classes.

The current draft standards do not look like science, technology, engineering or mathematics as practiced today in Ohio and around the world.

The Academy will not support the draft science education standards without the inclusion of technological design.

We suggest the attached *pro-forma* amendment to the standards to insert technological design as a parallel to scientific inquiry.

Mastery vs. Understanding *vis à vis* STEM education

With the exception of one, key word, the draft science education standards now include the Academy's Board-approved definition of STEM education. The ODE staff substituted "understanding" for "mastery", clearly lowering the standards and making them less rigorous. Both higher education and industry require "mastery" of subjects and not just understanding. Students must develop skills to **do something** not just know something.

Weak biology in PK-8

The biological content of the PK-8 draft standards is weak. In a word, "ignored" is how the PK-8 draft treats evolution. As a term—and concept—evolution does not appear in the PK-8 document. The PK-8 document only vaguely refers to evolution in terms of extinct organisms (fossils). The majority of Ohio elementary science teachers will not be able to teach evolution, the underlying tenet of modern biology, with this document. For example, natural selection and mutation—underlying concepts of evolution—are missing. For a teacher well-grounded in biology, this will not be a problem because he or she can relate the principles of evolution to the genetics, ecological and geological material in the PK-8 document. High school teachers fare much better because the biology syllabus covers most of the major principles of evolution. The major weakness of the high school biology syllabus in evolution is the lack of information on microorganisms as they relate to disease, health and industrial applications.

On a 0 to 10 scale, with ten being the highest, the PK-8 standards score a zero and the high school biology syllabus might score an eight.

How to plug the earth science hole in Ohio Core Curriculum

Finally, I want to bring a solution to your attention that will solve a gaping hole for high school students in the Ohio Core science graduation requirements. Giving recent news headlines related to earth science (deep ocean oil leaks, volcanoes, severe weather including floods, and carbon sequestration related to global climate change), it's disappointing that, beginning July 1, 2010, a student may graduate from an high school under the Ohio Core Curriculum with only an 8th grade understanding of earth and space sciences. Of the three required science credits, only life science and physical science are mandated.

Our reviewers tell that the proposed syllabus for an "advanced" geology course will intimidate most students. Accordingly, attached is a proposed amendment to the Ohio Core language to balance requirements for all students to take life science, physical science and earth and space science. Without the suggested change, conceivably a high school student could have no further exposure beyond the 8th grade to soil, water, weather and climate including the greenhouse effect, and the solar system and beyond.

Summary

In summary, the draft science education standards fall flat and are less effective than the 2002 standards because they avoid content on the nature and workings of contemporary science and are silent on technology and technological design. The draft standards are characterized best as “skill-less” with little fidelity to the skill sets articulated in Am. Sub. H.B. 1.

Accordingly, we recommend that:

1. The State Board of Education table the resolution to approve the science education standards to allow more time to resolve the deficiencies.
2. Short of tabling the resolution, move to accept our *pro forma* amendment to insert technological design as a parallel to scientific inquiry.
3. Agree to work with the Academy to plug the earth science hole in the Ohio Core Curriculum through legislation.
4. Revise the definition of STEM education to restore the term “mastery” for “understanding”.

I will be pleased to answer your questions. Thank you again.

APPENDIX

1. Table on the Status of Agreement ... **(see also handout)**
2. Table on the Comparison of the criteria for “skills” ... **(see also handout)**
3. Proposed amendment to the draft science education standards to incorporate technological design. **(see also handout)**
4. Proposed amendment to the ORC to require life science, physical science and earth and space science as an Ohio Core Curriculum requirement for high school graduation.

**Status of Agreement
between
The Ohio Academy of Science
and
The Ohio Department of Education/State Board of Education
on the
DRAFT Science Education Standards (May 25, 2010)**

<u>Academy's Recommendation</u>	<u>Status</u>
1. Simplify goals.	Completed; thank you.
2. Add measurable scientific inquiry standards.	Completed; thank you
3. Add measurable technological design standards in parallel to inquiry.	Not done; See separate <i>pro-forma</i> proposed amendment.
4. Emphasize cross-curricular skills especially from mathematics and English.	Not done.
5. Emphasize the nature of contemporary science.	Not done.
6. Articulate 21 st Century Skills.	Not done.
7. Develop and insert syllabus for 9 th – 12 th grade earth and space science course.	Not done. Requires legislation for full impact.
8. Include application of science.	Not done.
9. Improve high school syllabi.	Mostly done; skills still missing.
10. Include scientific ethics.	Not done.
11. Remove or correct teleological statements.	Done; thank you.
12. Tweak design of unifying logo.	Not seen recently.

The Ohio Academy of Science

June 7, 2010

Comparison of the criteria for "skills" in the academic content standards

from Am. Sub. H.B. 1

with the Draft Science Education Standards

Excerpts from Am. Sub. H.B. 1	DRAFT Science Education Standards	CORRECTION NEEDED	NOTES
128th Ohio General Assembly			
Sec. 3301.079. (A)(1) Not later than June 30, 2010, and at least once every five years thereafter, the state board of education shall adopt statewide academic standards with emphasis on coherence, focus, and rigor for each of grades kindergarten through twelve in English language arts, mathematics, science, and social studies.			
(a) The core academic content and skills that students are expected to know and be able to do at each grade level that will allow each student to be prepared for postsecondary instruction and the workplace for success in the twenty-first century;			
(b) The development of skill sets as they relate to creativity and innovation, critical thinking and problem solving, and communication and collaboration;	creativity and innovation (MISSING), critical thinking and problem solving (MINIMAL because of scientific inquiry), and communication (MINIMAL because of scientific inquiry) and collaboration (MISSING)	Embed measurable standards for creativity and innovation, critical thinking and problem solving strategies, and oral, graphic and written scientific communication and teamwork (collaboration from technological design); and add measurable technological design standards	This is the perfect opportunity to emphasize the need for the cross-curricula skills. Show and apply relationship to English Language Arts, Mathematics and Social Studies.
(c) The development of skill sets that promote information, media, and technological literacy;	information, media, and technological literacy (ALL MISSING)	Embed measurable technological design standards.	Perfect opportunity to emphasize need for cross-curricula nature of skills needed. Show relationship to English Language Arts (critical reading, non-fiction writing, citing sources, structuring written and oral arguments), Mathematics (measurement (esp. SI), decimal system, estimation, probability & statistics, algebra and problem solving) and social studies (history of science and technology, inventors, inventions and their impact on the economy and entrepreneurialism.)
(d) The development of skill sets that promote personal management, productivity and accountability, and leadership and responsibility;	personal management, productivity and accountability, and leadership and responsibility (ALL MISSING)	Embed aspects of the nature of science including ethics.	Perfect opportunity to emphasize cross-curricula skills needed.
(e) Interdisciplinary, project-based, real-world learning opportunities.	Interdisciplinary, project-based, real-world learning opportunities (LARGELY MISSING)	Embed measurable technological design standards and the nature of science.	Perfect opportunity to emphasize need for cross-curricula nature of contemporary of science as an integrated endeavor with technology, engineering and mathematics.

**Example of the addition of
Technological Design
for Ohio's Science Education Standards as recommended by
The Ohio Academy of Science.
March 8, 2010**

NOTE:

A detailed document, by grade spans, was submitted to The Ohio Department of Education on January 21, 2010. That document contained both the rationale and specific grade span additions for scientific inquiry and technological design standards. Subsequently, we are pleased that **scientific inquiry** was added, but the ODE staff members do not consider **technological design** important enough to include in the science standards in spite of the fact that our entire economy is strongly based on goods and services created through technological and engineering design. Moreover, Integrated STEM education is impossible without technological and engineering design (the "T&E" of STEM).

Eight other states already include technological or engineering design in their standards.

Science Pre-K

Theme: Observations of The Environment

This theme focuses on helping students develop the skills for systematic discovery to understand the science of the physical world around them in greater depth by using scientific inquiry.

All students at all grade levels must develop the ability to do scientific inquiry and technological design.

Scientific Inquiry

- Observe and ask questions about the natural environment,
- Plan and conduct simple investigations,
- Employ simple equipment and tools to gather data and extend the senses,
- Use appropriate mathematics with data to construct reasonable explanations,
- Communicate about observations, investigations and explanations,
- Review and ask questions about the observations and explanations of others.

Technological Design

- Define a problem or need,
- Gather and analyze information,
- Establish design statement or criteria for success,
- Prepare preliminary designs,
- Build a prototype and test multiple times,
- Analyze results; verify, test and redesign as needed,
- Communicate results to peers and community.

Strands

Strand Connections: Observations of physical properties of both living and nonliving things in local surroundings. This includes water, the sun, rocks and soil, human-made materials, and living organisms. This is to encourage students to examine their environment, its similarities and its differences.

Earth and Space Science

Physical Science

Life Science

Topic: Observations of Nature

This topic focuses on observing and describing the local natural environment.

Topic: Observations of Objects and Materials

This topic focuses on observing and describing properties of objects and materials that can be found in

Topic: Observations of Living Things

This topic focuses on observing and describing external, physically observable characteristics and behaviors of plants

**Suggested revisions in
The Ohio Core Curriculum
to give equal weight to earth and space sciences
with physical sciences and biology in grades 9-12.
June 3, 2010**

Beginning with students who enter the ninth grade for the first time on or after July 1, 2010, with some exceptions, the requirements for graduation from every public and chartered nonpublic high school shall include twenty units that are designed to prepare students for the workforce and college. Three units of science will be required with inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information, which shall include the following, or their equivalent:

- (a) Physical sciences, one unit;
- (b) Biology, one unit; and
- (c) **EARTH AND SPACE SCIENCES**, one unit.

~~;(d) Advanced study in one or more of the following sciences, one unit: (i) Chemistry, physics, or other physical science; (ii) Advanced biology or other life science; (iii) Astronomy, physical geology, or other earth or space science.~~

–Summarized and **modified** from AM. SUB. S.B. 311
126th Ohio General Assembly
Signed into law January 3, 2007

http://www.legislature.state.oh.us/bills.cfm?ID=126_SB_311