

NATIONAL  
ASSOCIATION  
of SCHOLARS



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May 16, 2024

Dear Virginia Department of Education,

The Virginia Department of Education (VDOE) seeks comments on the *2018 Science Standards of Learning* (hereafter *2018 Standards*) to increase concept clarity and inform updates to the structure of the standards. The National Association of Scholars (NAS) and Freedom in Education (FIE) work to ensure that every state has science standards that promote first-rate education. We have been asked by Virginia citizens to comment on the *2018 Standards*. We conclude that the *2018 Standards* are much better than the Next Generation Science Standards (NGSS), but they still fall short of providing schools and teachers the guidance they need to provide Virginia K-12 students the excellent, content-rich science education they deserve. VDOE should draft entirely new standards, upon a different educational philosophy, rather than simply revise the *2018 Standards*.

We divide our comments into *What Should Be Preserved*, *What Should be Revised: Rigor and Detail*, and *What Should Be Revised: Structure*.

## WHAT SHOULD BE PRESERVED

Virginia, to its great credit, has avoided virtually all influence from the NGSS. Other states, whose science standards derive from the NGSS, have done great damage to their public K-12 science instruction. The NGSS:

- Uses an entirely unclear format, that makes it virtually impossible to read.
- Phrases large amounts of its standards as questions rather than answers, due to its commitment to the ineffective or counterproductive “inquiry-based pedagogy.”
- Includes large amounts of politicized material and conflates science with political activism.
- Includes large numbers of pedagogical commitments to the “diversity, equity, or inclusion” (DEI) ideology.

We strongly endorse Virginia’s choice not to adopt or be influenced by the NGSS standards. The *2018 Standards* avoid most of the flaws associated with the NGSS model of science standards; Virginia’s revision should maintain this excellent strategic decision.

*Recommendation:* We strongly encourage VDOE in its revision to maintain the virtues the *2018 Standards* possesses throughout most of its content: lucid format, depoliticized content, no prompts to activism, and no pedagogical commitments to DEI ideology, or to any similar ideology.

## WHAT SHOULD BE REVISED: RIGOR AND DETAIL

The VDOE’s commitment to concision is admirable. Its commitment to teacher freedom also is admirable. We do not believe the state government should be micromanaging science teachers in the classroom, and the *2018 Standards*, by avoiding detail, leave much greater freedom to teachers. We applaud that.

Yet, we believe that providing teacher freedom does not preclude providing more rigorous content. Our concern for the *2018 Standards* is that they are too brief and vague to perform fully their functions as a guide to the breadth of knowledge a teacher and student should have. Standards need to have far greater length and detail for these purposes. The following are our rationales for why more rigor and content is warranted within the standards:

- State content standards provide minimum content knowledge standards for teacher education. Practically speaking, many schools of education and undergraduate education departments only require prospective science teachers to learn what is explicitly included in the state content standards. The *2018 Standards*, because they are both brief and vague, generally result in reduced science instruction to future science teachers.
- State content standards likewise provide minimum content knowledge standards for teacher licensure and professional development. The *2018 Standards*, because they are both brief and vague, likewise allow teacher licensure and professional development to reduce the amount of science instruction required of current science teachers.
- Science teachers, especially science teachers who have taken relatively few courses in science content, rely on science standards to help them determine what to teach. As a result, more detailed science standards help science teachers teach students day by day; less rigorous standards leave them adrift.

- Brief, vague content standards especially harm the education of disadvantaged students, and thereby foster an unequal society. When disadvantaged students receive intensive content instruction, they learn eagerly and well. Science content standards should offer comprehensive content knowledge to ensure that Virginia’s public schools fulfill the American promise of equal educational opportunities for everyone.
- State content standards provide minimum content knowledge standards for textbook companies seeking to serve Virginia public K-12 schools.
- Detailed science content standards give school districts more material to use to plan their own science instruction. Some school districts may want to shift the order of instruction for certain science topics. Other school districts may want to provide (for example) two years of high-school biology instruction before AP Biology and will want enough material to provide standards for two years of instruction. More detailed science standards provide more assistance and allows more freedom for school districts.
- Detailed science content standards facilitate reliable assessment, whether by national companies such as the Educational Testing Service (ETS), state-level testing, or tests by school districts and individual teachers. They provide enough material to make it easy both for teachers and for large organizations such as ETS to create tests that accurately assess student knowledge.

Most importantly, *brief, vague content standards encourage teachers to teach nothing but what is explicitly prescribed—an outline with too little substance*. They encourage schools to teach fourth-grade content in fifth grade, eighth-grade content in high school, and high-school content in AP classes—or never. College professors regularly tell us that students come to them unprepared due to insufficient instruction in content knowledge and scientific reasoning. We believe this is partially due to the lack of rigor in state standards. Brief, vague content standards enable this harm to the education of *all* students, by allowing them to receive a sketchy education that will not prepare them for college or career.

In **Appendix 1**, we provide examples from the *2018 Standards* to illustrate how VDOE might provide greater detail in its revision. In these examples, and throughout, greater detail will ensure that revised science standards will be effective at assisting teacher education, teacher licensure, professional development, textbook creation, teacher lesson plan creation, school district organization of science classes, assessment, equal opportunity for all students, and ensure a comprehensive science education that will truly prepare students for college and career.

*Recommendation:* The VDOE in its revision should provide much greater detail and much greater specificity.

### **WHAT SHOULD BE REVISED: STRUCTURE**

The *2018 Standards* contain substantial omissions and distortions. These include:

**Pedagogy.** The phrase “Students will investigate and understand” (*passim*) prescribes pedagogical method, when teachers should be free to choose whatever means will lead students to understand. It also suggests dependence upon the ineffective, counterproductive, and too-frequently politicized inquiry-based pedagogy, which will facilitate “investigation” that never leads to understanding.

*Recommendation:* VDOE in its revision should remove all references to *investigate*.

**History of Science.** The *2018 Standards* contain virtually no History of Science. Science instruction can be enriched by the history of scientific discovery, by helping both teachers and students to learn how we came to know what we know about the natural world. Learning the history of scientific discovery will help teachers plan the sequence of science instruction and the choice of laboratory experiments and field exercises. The history of science also helps students learn about how scientific debate works and may inspire them to choose careers in science.

*Recommendation:* VDOE in its revision should add explicit and thematic coverage throughout K-12 instruction of history of science to its science standards.

**Technology and Engineering.** The *2018 Standards* mentions “engineering practices,” but it includes no discrete instructional sequence of technology and engineering to underpin its commitment to the T (technology) and E (engineering) in STEM education.

*Recommendation:* VDOE in its revision should add explicit and thematic coverage throughout K-12 instruction of technology and engineering to its science standards.

**Mathematics.** The *2018 Standards* broadly prescribes mathematical knowledge, but it provides no actual mathematical knowledge in its science standards. Even the high school Chemistry and Physics standards include no mathematical formulas; for example, the *2018 Standards* mentions Ohm’s law (PH.8.b, p. 47), but does not define it.

*Recommendation:* VDOE in its revision should add explicit and thematic mathematical knowledge throughout K-12 instruction to its science standards, including scientific formulas of increasing complexity in middle school and high school. VDOE also should add explicit and thematic expectations of Mathematics Corequisite Knowledge to its science standard, keyed to an expectation that Virginia students will take Algebra I in Grade 8.

**Earth Resources.** The *2018 Standards* politicizes science instruction by incorporating substantial amounts of environmental polemic throughout its Earth Resources strand, which prompts students to engage in environmental activism (e.g., K.11.c, p. 10; 1.8, p. 13; 3.8, p. 19; 6.[Introduction], p. 26; 6.9, p. 28; ES.6, p. 43; ES.10.e, p. 44; ES.11.c-d, p.44; ES.12.e, p.44). This polemic is softly phrased, but constant, and it subordinates science instruction to political activism.

*Recommendation:* VDOE in its revision should remove the Earth Resources strand. Any purely scientific material should be incorporated into Living Systems and Processes and Earth and Space Systems. VDOE should ensure no material incorporates environmental polemic or prompts students to engage in environmental activism.

**Nature of Science.** The *2018 Standards* provides far too brief and vague an explanation of the nature of science: “Science is not a mere accumulation of facts; instead, it is a discipline with common practices for understanding the natural world.” (v)

*Recommendation:* VDOE in its revision should provide a detailed, precise, and lucid explanation of the nature of science, including;

- its presumption of the existence of objective reality, the capacity of human senses and reason to achieve knowledge of objective reality, the existence of the natural world as a distinct domain of inquiry, and that the natural world is governed by uniform laws and processes which may be described, explained, and used to predict what will be observed under future specific conditions;

- precise definitions of scientific facts, theories, hypotheses, experiments, and laws;
- defining and distinguishing between *cause* (one thing causes another) and *correlation* (two things occur together);
- the limits of scientific knowledge, including that scientists sometimes may be fallible, that sometimes they are motivated to become self-interested observers, that they may overestimate the extent of their expertise, that they may sometimes lack full data about the object of scientific inquiry; and that scientific methodology should be used cautiously when assessing subjective human attitudes, beliefs, and opinions and is limited to the observable natural and objective world; and
- scientific character, including recognition that there are many obstacles in the search for truth, including the concealment of one's own biases and ignorance and the blind acceptance of authority, tradition, and consensus.

**Scientific and Engineering Practices.** The *2018 Standards* broadly prescribe scientific process knowledge, often referred to as “skills,” under the name of “scientific and engineering practices.” These standards generally are phrased in unclear, bureaucratic, and abstract language. They do not make explicit reference to the scientific method as a unique and necessary means of acquiring scientific knowledge.<sup>1</sup> They also prescribe excessive reliance on models,<sup>2</sup> whose value for scientific knowledge is limited and unreliable, and which have been subordinated to political activism in fields such as climate and public health policy. Nor does their prescription on communicating knowledge culminate in the concrete direction to learn how to write a science research paper.

*Recommendation:* VDOE in its revision should use concise, concrete, and lively language for Scientific and Engineering Practices, making sure that it does not prescribe abstract “skills” that are equally applicable to other disciplines (e.g., social studies, ELA, mathematics).

*Recommendation:* VDOE in its revision should add explicit coverage of the scientific method, define it, and state why it is a unique and necessary means of acquiring scientific knowledge.

*Recommendation:* VDOE in its revision should emphasize far more emphatically instruction in the limitations of models for acquiring scientific knowledge.

*Recommendation:* VDOE in its revision should add to its “communicating information” items a K-12 sequence culminating in the high school science courses in items on how to write science research papers.

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<sup>1</sup> The one reference to scientific methodology (v) is brief and vague.

<sup>2</sup> Introduction (v); K.1.e (p. 8); 1.1.e (p. 11); 2.1.e (p. 14); 3.1.e (pp. 17-18); 4.1.e (p. 20); 5.1.d-e (pp. 23-24); 6.1.e (p.28); LS.1.e, (p. 29); PS.1.e (p. 33); BIO.1.a,c,d,e pp[. 35-36); CH.1.a,c,e (pp. 38-39); ES.1.a,c,d,e (pp. 41-42); ES.12.d (p. 44); PH.1.a,c,d,e (pp. 45-46). The *2018 Standards* do secondarily acknowledge the “limitations of models” (5.1.e, p. 24; 6.1.e, p. 28; LS.1.e, p. 29; PS.1.e, p. 33; BIO.1.e, p. 36; CH.1.e, p. 39; ES.1.e, p. 42; PH.1.e, p. 46), but these limitations are so great that VDOE should teach the shortcomings of models as their primary characteristic.

**Politicization.** The *2018 Standards* contains politicized vocabulary, some of it a prompt for action civics<sup>3</sup> conducted in the science classroom, including *authentic* (iv), *solve societal problems* (iv), *the needs of society* (vi), *societal needs* (PS.5, p. 33), and *Make informed decisions regarding contemporary civic, environmental, and economic issues* (iv), *think critically* (v; and see vii), *problem-solve* (v). The Profile of a Virginia Graduate (vii), with its unclear format, its subordination of “Planning and carrying out investigations” to “Collaboration,” and its invocation of *critical thinking, civic responsibility, resource use, impacts* [sic]<sup>4</sup> of decisions and *collective action*, seems designed to facilitate politicization.

*Recommendation:* VDOE in its revision should remove all politicized vocabulary, especially all prompts to action civics.

*Recommendation:* VDOE in its revision should remove the Profile of a Virginia Graduate.

*Recommendation:* VDOE in its revision should replace all references to *critique* or *critical thinking* with “analysis” and “analytical thinking.”

**Evolution.** The *2018 Standards* treats evolution briefly and circumspectly (LS.11, p. 31; BIO.2, p. 36; BIO.7, p. 37). It is understandable that VDOE would seek to avoid creating contention on an extremely divisive subject. The result, however, is that the *2018 Standards* provides insufficient coverage both to the Neo-Darwinian theory of evolution and to the complicating or competing scientific theories of evolution.

*Recommendation:* VDOE in its revision should provide detailed coverage both of the Neo-Darwinian theory of evolution and of complicating or competing scientific theories of evolution such as Gould and Eldredge’s concept of *punctuated equilibrium* and Lovelock and Margulis’ *Gaia hypothesis*.

*Recommendation:* VDOE in its revision should distinguish explicitly between the scientific question of the origin of life and the scientific evidence and theories of evolution.

*Recommendation:* VDOE in its revision should incorporate systematic instruction on the distinction between scientific facts, hypotheses, and theories, to provide a proper background for discussion of evolution, including distinction between the evidence for evolution and theories about the mechanisms of evolution.

*Recommendation:* VDOE in its revision should phrase its treatment of evolution to ensure that students are asked to *know* the scientific theories of evolution, but not asked to *declare their belief* in any theory of evolution.

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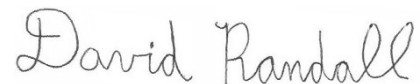
<sup>3</sup> Stanley Kurtz, “‘Action Civics’ Replaces Citizenship with Partisanship,” *The American Mind*, January 16, 2021, <https://americanmind.org/memo/action-civics-replaces-citizenship-with-partisanship/>; Thomas K. Lindsay and Lucy Meckler, “Action Civics,” “New Civics,” “Civic Engagement,” and “Project-Based Civics”: *Advances in Civic Education?* (Texas Public Policy Foundation, 2020), <https://www.texaspolicy.com/wp-content/uploads/2020/09/Lindsay-Meckler-Action-Civics.pdf>.

<sup>4</sup> The incorrect use of *impact* and *impacts* should be replaced throughout with words such as *affects*, *effects*, and *consequences*.

## Conclusion

The Virginia Department of Education's proposed *Standards* possess significant virtues, but they also possess substantial shortcomings. We urge VDOE to revise the *2018 Standards* in detail as we have recommended. Indeed, we have drafted and would be delighted to share an alternative approach to science standards, for your consideration as a way to inform Virginia's revision of its science standards.

Respectfully yours,

A handwritten signature in black ink that reads "David Randall". The script is cursive and fluid.

David Randall  
Director of Research  
National Association of Scholars

A handwritten signature in black ink that reads "Melissa Jackson". The script is cursive and elegant.

Melissa Jackson  
President  
Freedom in Education

## Appendix 1

Below are examples from the *2018 Standards* that illustrate how VDOE might provide greater detail in its revision.

Kindergarten. The *2018 Standards* states that students should know that “living organisms have certain characteristics that distinguish them from nonliving objects” (K.6.b, p. 10). The revision should specify that *all living things take in nutrients, grow, reproduce, eliminate waste, and die*.

Grade 2. The *2018 Standards* states that students should know that “wind and weather can change the land” (2.7.b, p. 15). The revision should specify that *dynamic processes that wear away Earth’s surface include weathering and erosion, the process of weathering breaks down rocks to form sediment, and soil consists of sediment, organic material, water, and air*.

Grade 5. The *2018 Standards* states that students should know that “matter is composed of atoms” (5.7.a, p. 25). The revision should specify that *atoms are far too small to see with a light microscope; there are 92 naturally-occurring types of atoms (elements) as well as some that are made artificially; the atoms of each of the elements have different properties; the elements are arranged by their properties on the periodic table; the periodic table was used to predict the existence of unknown elements; and it took until the early twentieth century (1905) for physicists to come up with a theory and experiments to provide convincing evidence for atomic theory*.

Grade 8. The *2018 Standards* states that students should know that “motion can be described using position and time” and “motion is described by Newton’s laws” (PS.8.a-b, p. 34). The revision should specify that *the motion of an object is always judged with respect to some other object or point (frame of reference); the change in position of an object with respect to time is its velocity and the change of the velocity of an object with respect to time is its acceleration; the acceleration ( $a$ ) of an object is related to its mass ( $m$ ) and the applied force ( $F$ ;  $a = F/m$ ), and for every action there is an equal and opposite reaction*.

Biology [High School]. The *2018 Standards* states that students should know that “the structure and function of the cell membrane support cell transport” (BIO.3.c, p. 36). The revision should specify that *Transport molecules embedded in the plasma membrane manage the flows of hydrophilic materials across the membrane; and that substances may cross the plasma membrane in three ways: diffusion, in which a substance is transported down a concentration difference across the lipid portion of the membrane; facilitated transport (facilitated diffusion), in which a hydrophilic substance is transported down a concentration difference, via embedded membrane proteins; and active transport, in which an embedded protein uses the energy of ATP to transport a hydrophilic substance against its concentration difference*.<sup>5</sup>

In all these examples, the revisions replace vague outlines with detailed, scientifically accurate content matter, which help teachers by stating precisely what they should convey to students.

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<sup>5</sup> Content-rich standards with greater detail should provide scaffolded instruction that prepares students to understand these concepts when they take high school science courses.