The Next Generation Science Standards:
Junk Science in Wyoming's Schools

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The NGSS (and Common Core) should be removed from Wyoming education, based on the following evidence:

1. National education standards result in losing local control

The adoption of national science standards would mean Wyoming has again been seduced by promises of unproven and controversial nation-wide education "solutions" that we didn't participate in. This would be another inappropriate step towards giving up local control. If this happens, it would violate Wyoming's sovereignty in direct opposition to the concept of a republic.

2. The NGSS do not prepare students for college and careers - Fordham

The specific standards identified in the NGSS (http://www.nextgenscience.org/sites/ngss/files/NGSS%20Combined%20Topics%2011.8.13.pdf) identify what "students who demonstrate understanding" can accomplish. Unfortunately, NGSS will not help Wyoming students prepare for STEM or any other careers; rather, it will be a severe hindrance to gaining even basic knowledge and understanding of critical science concepts.

A bold claim? Not at all, if people actually read the NGSS and the comments of the Fordham Institute (http://www.edexcellence.net/), which is self-described as…

> "…the nation's leader in advancing educational excellence for every child through quality research, analysis, and commentary…"

Fordham is also involved with, and generally supportive, of national programs, including the Common Core State Standards (CCSS).

Let's start with a 2013 Fordham Institute commentary titled
Next Generation Science Standards Revisited
(http://www.edexcellence.net/commentary/education-gadfly-weekly/2013/august-22/next-generation-science-standards-revisited.html)

authored by researchers Chester E. Finn, Jr. and Kathleen Porter-Magee. The authors gave NGSS a "C" grade – just average. Were they biased against NGSS or perhaps they are anti-science, as Wyoming parents have been accused of being??

In their words, the authors were…

> "…using substantially the same criteria as we previously applied to state science standards—criteria that focus primarily on the content, rigor, and clarity of K–12 expectations for this key subject—our considered judgment is that NGSS deserves a 'C'."

For all the time and money NGSS has consumed (and discontent it has generated), a "C" grade hardly seems like a good investment to raise Wyoming's science capabilities from an "F' (also awarded by Fordham).

What did Finn and Porter-Magee base the "C" grade on? A review of the Foreward that Finn and Porter-Magee also authored for Fordham Institute's **Final Evaluation of the Next Generation Science Standards** (Paul R. Gross, et al; June 13, 2013) addressed the following findings by the report's authors:

> "First, missing and "implicit" content. Pruning and prioritizing can be taken too far, and it does nobody any favors to pretend to omit content from one grade that later turns out to have been essential. Yet the NGSS sometimes does precisely that: it never explicitly requires some content in early grades that is then assumed in subsequent standards."
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> "This problem is especially visible in the earth and space science section, where (in the review's words) "so much implied content is inferred in a single statement that it is difficult to imagine just what one might expect to be taught."

Additionally in the Foreward of the same report, Finn and Porter-Magee offer up…

> "Second, the risk posed by including "assessment boundaries" along with the standards. These are meant to cap large-scale assessments—to put a ceiling on the content and skills that will be measured at each grade—not to limit curriculum or instruction. The likely reality, however, is that such assessment limits will needlessly constrain what is taught and learned, particularly in advanced classrooms and for high-achieving pupils. The assessment boundaries articulated in the NGSS too often reduce the rigor or narrow the content of the standards when we could (indeed should) expect more."

Finn and Porter-Magee continue with yet another area of high concern:

> "Third, the failure to include essential math content that is critical to science learning. As our physics and chemistry reviewers explain:
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> *"In reality, there is virtually no mathematics, even at the high school level, where it is essential to the learning of physics and chemistry. Rather, the standards seem to assiduously dodge the mathematical demands inherent in the subjects covered. There is math available in the Common Core that could be used to enhance the science of the NGSS. No advantage is taken of this."*

The NGSS Revisited commentary closes with this additional information on that core concept of NGSS know as "College and Career Readiness":

> "NGSS aficionados and doubters alike should also be aware of the recently-issued Appendix C (available on the NGSS website) titled "College and Career Readiness" (http://www.nextgenscience.org/sites/ngss/files/NGSS%20Appendix%20C%20Final%20072613.pdf).
> They will find wordy pages that read as if they might be intended to refute our review of NGSS. **Mostly, they argue against overburdening science education with too much content!** In this way, they underscore the importance of our principal criticism."

3. Reliance on Clarification Statements in the NGSS

With the Fordham analysis as motivation and guidance, a closer look at NGSS is warranted, beginning with concerns around "content". In addition to Fordham's concerns about "what" is being taught, the issues of the accuracy of "what" and how much "prompting" comes into play. In short, the NGSS are not only poor standards, but also poor curricula.

Curiously, **92%** (176 of the 191 specific standards) of the NGSS include a "Clarification Statement" which provides numerous specific examples of activities that students "could" and "should" engage in to "demonstrate understanding".

The prevalence and content of the "Clarification Statement" is akin to requiring these and only these curricula and activities, thereby negating frequent claims ("these are standards, not curriculum") by NGSS supporters that the specifics of education will still reside under the purview of local districts and the classroom teacher. They will not – the specifics of education will reside in the NGSS and the associated testing/assessments.

Examples provided below, with added highlights, are a few of the dozens of errors in facts, errors in concepts and blatant political indoctrination in the NGSS:

"K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.
[Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and that all living things need water.]"

Plants not needing food will be news to the agriculture industry across the country that knows CO_2 and various nutrients are "food" to plants, regardless of how some political groups regard CO_2.

"3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
[Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between

an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.]"

With this much instructional detail (curriculum), a sharp 3rd-grader could probably teach the topic.

"4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
[Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; nonrenewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]"

The topic is apparently "good" renewable Energy, predictably wind and sunlight. A more useful discussion of energy would focus on issues of energy density and land use, comparing the ratio of *total footprint to energy produced*: energy conversion (wind and sunlight) v. fossil v. nuclear, where the poorest ratio is found in energy conversion systems. An honest evaluation would also show the impacts from solar panel/wind turbine manufature and operation as part of the comprehensive comparision between energy sources.

The following is the standard for Human Sustainability in high school. I leave it to the reader to evaluate this standard for inappropriate indoctrination content as well as the "non-curriculum" nature of the Clarification Statement and Assessment Boundary concepts.

"HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
[Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals

and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]"

"HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
[Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]"

"HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
[Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]"

"HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
[Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]"

"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.
[Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.]
[Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]"

Do competent classroom teachers require a "Clarification Statement" in order to teach to the "standards"? This same "clarification" also prevails in the Common Core State Standards through its use of both implementation documents and extensive teacher training.

Why is that? A "professional" in the workplace, bringing appropriate knowledge, skills and experience as an educator, should not require "prompts" or "suggestions" as to how to develop students' understanding.

In reality, such "prompts" are only necessary for educators not skilled nor knowledgeable in science. Dependance on what NGSS puts forth is then instilled and perpetuated, essentially the "world according to NGSS". This amounts to broad-spectrum indoctrination as seen above, with the subsequent loss of local initiative and control.

Additionally, the Common Core State Standards connections to NGSS are guilty of this same "leading by the nose" content, providing very specific and detailed material. For example, the following is linked to High School Life Sciences:

Common Core State Standards Connections: ELA/Literacy – SL.11-12.5
Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-4)

In summary, the provided Clarification Statements do not alleviate concerns about content inclusion or accuracy and only support claims that the NGSS are essentially national curricula and testing that cannot be deviated from.

4. The Limitations of Assessment Boundaries in the NGSS

Fordham's concern about the limitations imposed by the Assessment Boundaries is supported repeatedly throughout the NGSS. Additionally, the specific problems found in the Clarification Statements (errors of fact, errors of concept and blatant political indoctrination) are also present in the Assessment Boundaries.

Fully **66%** (127 of the 191 specific standards) of the NGSS include an "Assessment Boundary", providing clear direction on what won't be covered in the assessment of students' ability or knowledge. In other words, what won't be on the test. Why would competent classroom teachers require a "Assessment Boundary" on 2/3 of the standards in order to assess students' abilities?

In 5th grade, students are significantly impacted:

"5-PS1-3. Make observations and measurements to identify materials based on their properties.
[Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.]
[Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]"

Ignoring the relationships between hardness and density, as well as the difference between mass and weight is akin to educational malfeasance for this age. Add to this the following:

"5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.
[Clarification Statement:

"Down" is a local description of the direction that points toward the center of the spherical Earth.]
[Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]"

Understanding gravitational attraction is not beyond the abilities of this age group; "down" as the explanation for gravity is incorrect and terribly misleading. Also, is there a non-spherical Earth that might be examined?

Taken in combination with **5-PS1-3** above, a series of critical foundational concepts related to physics and space science are lost or mispresented based on these "standards", "clarifications" and "assessments".

"5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
[Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).]"

This will result in low-level, misleading simplistic understanding of stars; the assessment should contain the "other factors" mentioned. Again, this age has the capability to go well beyond the limitations of the NGSS.

Also, "Sun" should be capitalized as a proper noun.

The poor quality of education dictated by the NGSS and the Clarification Statements is further reduced by severe limitations imposed by the Assessment Boundaries – essentially they determine what isn't on the test and therefore likely to not be taught.

5. Qualitative versus Quantitative – Soft "Science" v. Hard Science

Fordham's "revisitation" of the NGSS identified the lack of math content as yet another weak and undesirable component to these national standards.

Unfortunately, in line with the discovery of both questionable content and the lack of critical content in the Clarification Statements and the Assessment Boundaries, math education is not only missing in the NGSS –

it has been replaced by a preference for "qualitative" analysis in critical areas.

Why is that? If the NGSS and Common Core are supposed to be the penultimate corrective force for what ails American education, why would the desirable early (and frequent) exposure to math tools be relegated to second best?

In reading the entire NGSS document, suspicions are confirmed that these national programs are merely the latest pipe dreams of the "Educational Industrial Complex". This becomes remarkably clear when we evaluate the NGSS in terms of the influences of the "social" (soft) sciences. Quantitative analysis is often seen as being too limiting or restrictive, while impressions, opinions and the ever-present "feelings" are much more "human" and "social".

Certainly, conducting genuine hard science requires skills, discipline, and appropriate balance using both quantitative and qualitative methods. Unfortunately, the NGSS miss numerous quantitative learning opportunities by some 26 directives favoring "qualitative" analysis over "quantitative". These are wasted opportunities to effectively bring numeric tools to students, particularly in the younger grades where math familiarity, acceptance and competence are critical for future success.

Examples include:

"1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.
[Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.]
[Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]"

Which is more useful to a student – "I think the days are shorter in the winter" – or determing length of the day seasonally and incorporating sunrise/sunset data as evidence?

"2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.

[Assessment Boundary: Assessment does not include quantitative scaling in models.]"

This is a missed opportunity to measure landforms, incorporate map reading, introduce Google Earth use, etc. – useful and enjoyable for 2nd graders.

"4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
[Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]"

Differences are important and measurement, not opinion, determine and explain those differences.

6. SUMMARY STATEMENT

Five negative issues regarding the adoption of and content in the NGSS have been stated and examined. Independent analysis of the NGSS document supports broad concerns identified by the nationally-recognized education research firm Fordham Institute: lack of content, limitations imposed by assessment boundaries, and lack of math concepts. In examing those broad concerns, specific and detailed problems were uncovered and provided: numerous errors of fact, errors of concept and blatant political indoctrination. The weakness and inappropriate nature of pervasive curriculum-like clarification statements and assessment boundaries is discussed, as are unscientific quantitative v. qualitative assessment issues, through examples taken directly from the NGSS document. Taken together, a useful overview of the dozens of poorly written directives that constitute the bulk of the NGSS is presented and is sufficient reason to reject and discard this national education initiative being imposed on Wyoming students, parents and educators.

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