The Link Between Student Learning and Engagement and Reducing Greenhouse Gases

Abby Ruskey, Education and Sustainability Specialist
Fellow, U.S. Partnership for Education for Sustainable Development

STEM Education Innovation Alliance
February 14, 2017
Washington State Capitol Campus, Olympia, WA

Thank you, Gene and to all who planned and prepared for such a wonderful event including John Aultman, John Snyder, Ellen Matheny, Ellen Ebert, Rochelle Gandour-Rood, Kathryn Kurtz, Tom Hulst, Lisa Eschenbach, Becky Wallace and Dan Tedor!

What fantastic STEM presentations from the 7 teams from Columbia Crest A-STEM Academy in Eatonville, Bordeaux Elementary in Shelton, Evergreen Middle School in the Everett School District, Taholah High School in Taholah, Sumner High School, Colton High School and Tesla STEM High School in Redmond! You students and teachers are brilliant and your parents, community partners and school administrators are the support system that it takes!

- How many of you feel that you could, in a conversation with family, neighbors, staff or classroom describe why climate change is happening and what can be done?

- How many believe that in your community, this state and across the U.S. we will actually be able to do what needs to be done in time to balance the CO_2 cycle and stabilize life on earth for this and future generations?

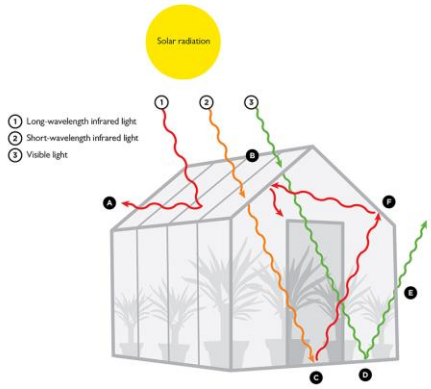
It's great to see that these students feel confident about describing the problem. As for knowing solutions, a Yale University survey showed that 93% of Americans do not believe that "humans can reduce global warming and we are going to do so successfully".

The late great Greek essayist—you could say one of the first bloggers— Plutarch said ***"The mind is not a vessel to be filled, but a fire to be kindled."*** These students have all ignited everyone's fire here today. It is great to see inspiring, state-of-the art teaching and learning that also results in treasuring our clean air, land and water; the source of good health, a strong economy and a very good quality of life for Washington residents.

You remind me of when I was 13 and traveled door-to-door in my Colorado mountain community as a certified "Community Energy Engineer". My school mates and I informed homeowners about how to build solar hot water collectors and greenhouses and grow food, including tropical plants at 8,500 feet. That year we presented to scientists at Los Alamos Laboratories in Santa Fe, NM and held a "Sundance" cultural and science exchange with Navajo students. That summer, some of us helped teach pre-service classes at the University of Wyoming about interdisciplinary, hands-on, collaborative learning. I joined 4-H and won a ribbon at the Colorado State Fair for my subtropical star-anise plant that I nurtured from a seed, along with the solar bead-wall I helped design and build to insulate our greenhouse

tropical room. That was the year a *bonfire* was lit in me for clean energy, a healthy environment and relevant, quality learning for <u>all</u> students of all socio-economic backgrounds, all around the world!

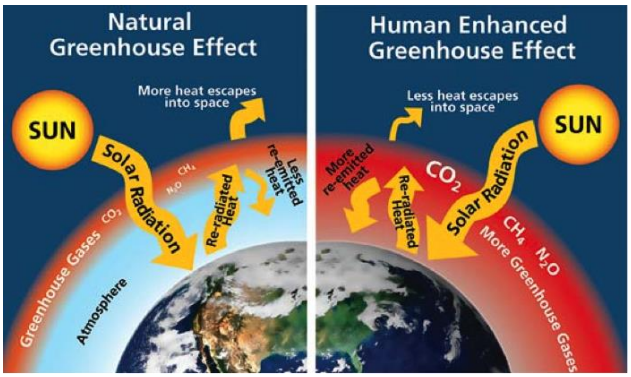
So, when I heard Governor Inslee ask why our state's students can't tell him what the greenhouse effect is (students here today notwithstanding!), my life flashed before my eyes. The first lesson I learned in the school program I described above was the greenhouse effect.



Solar radiation of varying wavelengths come through our atmosphere and windows and hit a solid surface and some rays reflect back as a thermal or infrared heat wave that cannot penetrate back through the glass (or atmosphere) and the container—whether the inside of a car, or a room on a sunny day, or the thin membrane of the spherical atmosphere surrounding the Earth—will continue to heat, unless mitigated. From that simple concept, life can be greatly enhanced … or very much threatened.

When I was your age (to the MS & HS students), the greenhouse effect was important to know about because it helped us learn how we could capture heat waves and convert that into radiant heat in homes and hot water collectors ***to save energy***. Back then, there were gas shortages and the "crisis" was the limits to, and geo-politics of, fossil fuels given that about half the big oil reserves were in the Middle East (Iran and Saudi Arabia). There was also great concern about air and water pollution from the emissions and manufacturing of fossil fuels and the resulting environmental movement led to agencies like the USEPA and the WA Department of Ecology and to laws and programs that really made a difference.

Today, the vast majority of U.S. and global scientists and business, governmental, and community leaders agree that the "Greenhouse Effect" represents a planetary life threatening crisis. Greenhouse gases—including carbon dioxide, methane, nitrous oxide, ozone and water vapor—have been piling up in our atmosphere and holding heat which is disrupting weather patterns. And this is resulting in a warming effect over time that is raising sea levels, likely intensifying catastrophic storms and fires like we saw this summer, threatening our food systems and other species, increasing the incidence and spread of infectious diseases and social and financial disorder.



While the science dates back to late 1900's, it wasn't until 1988 that world leaders began to regularly and scientifically assess and offer policy makers input on its impacts, future risks and methods to address these. This was the year the Intergovernmental Panel on Climate Change (IPCC) was created by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP).

Also, in 2006, Vice President Al Gore's movie "An Inconvenient Truth" put our climate change predicament – I prefer the term "climate breakdown"—on the big screen and into the public eye, at least the eye of those who chose to see. Many years went by without any *effective, concerted* political, business or grassroots leadership. However, during that time, the scientific consensus *did* firm up, preceded by scientist's alarm at the *unexpected rate of warming* at both the north and south poles, increased moisture, natural disasters, and ocean acidification.

Then in 2015 IPCC Paris Accord resulted in a world-wide commitment, nation by nation, to limit greenhouse gases to levels to slow and stop temperature rise at between 1.5-2 degrees Celsius (3.6 degrees Fahrenheit) by 2100. Since Paris, scientists world-wide have raised the alarm that we actually need to be on the path with plans, policies, and changes underway much sooner, by 2020 for new clean energy behaviors and technological and economic systems to be in place between 2030-2050 in order to avoid catastrophic climate breakdown.

That is pretty sobering…but nothing that WA **STEM** students and leaders can't tackle, right? What I just described gives us a picture of the **S**cience, both atmospheric and political. Now, let's take a look at **T**echnology, **E**ngineering and **M**ath. What exactly are we dealing with here? ***What*** can be done and ***who*** will do it? Here's where you will need a pen and paper…

How many have heard about the book *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*, by Paul Hawken and hundreds of scientists across the globe?

Drawdown illustrates the top 100 substantive solutions with a cost benefit analysis that could be deployed across the globe over a 30-year period. Given the anticipated rate of growth, the "Optimum Scenario" will reduce the amount by **1,613 gigatons** and be a completely clean energy future and a livable planet. *Write that figure down,* 1,613 gigatons. The "Plausible Scenario" including a mix of energy sources like nuclear and waste to energy in addition to global deployment of renewable resources, energy conservation and sequestration would result in **1,051 gigatons** of greenhouse gas reduction and *moderately livable planet*.

But, do these figures mean anything to you? Who here can tell me how much weight is in a gigaton? How many pounds in 1 ton? 2000 pounds. 1 metric ton = 2,205 pounds. 1 gigaton = **one billion metric tons** or the equivalent weight of **400,000 Olympic sized swimming pools full of water**. (Gases can add up to a lot of weight.) Multiply that by 1,613 and that's roughly our target to reduce greenhouse gases and sequester or draw down CO_2 for a livable future.

Between 1850-1990 we added 1,010 $GTCO_2$ to the atmosphere. Between 2000-2015, we added 500 $GTCO_2$ and in 2016 alone, 36 $GTCO_2$. Our remaining "carbon budget" by 2018 is 260 $GTCO_2$.

At our current global rate of 36 $GTCO_2$ annual missions, we have approximately 7 years left to begin to significantly ratchet-back GH gases across the globe in order to not exceed the Paris Agreement goal of remaining below 2 degrees Celsius, or 3.6 degrees Fahrenheit.

If we can get on track, global emissions should peak around 2020 and fall to near zero by 2050-2070 to improve the probability of global average temperature remaining below 2°C, as stipulated by the Paris Agreement 21. The problem is, there remains a substantial gap between emission reductions targeted and the rate of reduction currently underway.

Math has helped us know the amount of *greenhouse gases to reduce* while we *also increase methods to sequester* CO_2. With the Paris Agreement we have internationally agreed upon targets and national and subnational (state, towns/city, college/university networks) commitments to meet these targets.

Drawdown gives us the ***how***, including **S**cience, **T**echnology and **E**ngineering solutions along the lines of the projects presented by students today; regenerative agriculture and nutrient management, managed grazing, reduced food waste and recycling/upcycling, composting and terracycling, water and energy conservation, clean electricity, and biking and clean transportation. Students also demonstrated use of STEM by testing ocean acidification and the impacts on organisms of road run-off, along with coding interactive sustainability computer games for younger students, and creating a nation-wide high school network pledging action to meet the Paris "under 2°C" goal. They're also contributing to Drawdown!

Today's outstanding student presentations combined with the global targets and leadership behind the Paris Agreement, stand-out leadership of our Governor and Superintendent of Public Instruction, subnational activity across the nation and globe, and the excellent plan offered in *Drawdown* should provide some ideas and inspiration.

And here's another reason to have hope that we can meet, even exceed the Paris Agreement goals, and transition to a thriving, generative and just green energy economy in the process:

After closely analyzing and modeling *Drawdown* climate action strategies (CAS), scientists from the Swedish Royal Academy of Sciences, Stockholm Resiliency Institute, Future Earth, University of Budapest, Project Drawdown and myself have discovered that we can make the most rapid and effective progress to deploy climate solutions the at the scale of the size of a large neighborhood, school or average school district in Washington (1,000 to 3,500 people) to that of mid-sized cities, town clusters, or large corporations (10,000 to 100,000 people). In other words, what currently feels overwhelming and out of reach is actually in our hands to achieve at the organizational and community level!

How many cities over 1 million are there in WA? Answer: 0
How many are 100,000 to 220,000? Answer: 9
How many between 10,000 -100,000 (our research "sweet spot") Answer: 75!
Olympia, 54,000

What's the population of the Seattle School District? 53,000
Everette SD? 20,000
Population of Colton: 466 Tahola? 840
How many K-12 teachers in Washington? 64,323
WA Students?: 1.1 million
How many employees at Microsoft? 124,000
How many employees at Boeing? 174,225
BMGF? 1,383
Student population at UW? 48,081
Student population as WSU? 29,868

Furthermore, and here's the most exciting part for those gathered today; we further have evidence that the key to activating "agency" in people to take climate action is education! The students, teachers, school administrators, parents and education and policy leaders here today are proof of this. In other words, the community (1,000-100,000) scale is the place to activate climate action strategies—and rapidly curb and sequester greenhouse gases— providing there is also alignment with larger scale solutions and policies (at the state to global levels) such as those led by Governor Inslee, Superintendent Reykdal and the Intergovernmental Panel on Climate Change (IPCC), and strong amplification of individual, household and neighborhood efforts such as those illustrated by our school and community partners here today.

You are the first group on the planet to get a preview of these research results! We utilized a logarithmic scale recognizing that there are 10 orders of magnitude between every individual on the planet (10^0) up to 10 billion people (10^{10}), the projected population of the planet by 2050. From this we are able to propose a new framework to make rapid progress empowering people in communities around the world to identify potential climate solution interventions contextualized to where they live. Our paper will be submitted shortly and I will be sure to make it available once published this spring through Gene Sharratt to everyone here.

Our Governor, Jay Inslee says, ***"What we individually treasure, we must collectively protect."***

The stakes for all have never been greater for what we all treasure, and indeed rely upon for our very survival…and never before have we had such a colorful pallet of resources and talent for brilliant innovation and bold individual to systemic transformation in our society and economy. If not Washington where? Where else could the original instructions embedded in Indigenous Knowledge be combined with conservation aquaculture, and quantum computing to name just a few of our state's deep interdisciplinary pools of knowledge and innovation?

Thank you all for your time and leadership! I challenge you to further find avenues in your STEM organizations, and communities in which you live, to begin activating climate change awareness, skill development and transitions towards the new clean economy that Washington State will no doubt go down in history as having led.

COMMUNICATION PLAN FOR NEXT GENERATION SCIENCE STANDARDS

Washington State Board of Education

Jeff Estes, *Board Member*, Washington State Board of Education
Alissa Muller, *Communications Manager*, Washington State Board of Education

Introductory Remarks (Jeff Estes)

Thank you for providing Alissa and me time to talk with you about the SBE's approach for communicating about the Next Generation Science Standards.

Before we begin, let us compliment your communications efforts related to STEM. The presentations we just witnessed and the STEM Report Card you produced are great examples of the way you are making your STEM messages "stick."

Your efforts:

1. Communicate the core of your message,
2. Capture and hold people's attention,
3. Help people understand and remember what is critical,
4. Get people to believe in the value of STEM,
5. Get people to care about STEM, and
6. Get people to act in ways that support your STEM agenda.

The State Board of Education's work in science, mathematics and career and technical education is well aligned with the K-12 efforts of the Alliance. We applaud your 2018 recommendation to inspire interest in preparation for STEM careers through career-connected learning and enhanced STEM curricula, including your emphasis on the 1) the High School and Beyond Plan, 2) teacher professional development that supports mathematics and NGSS, 3) dual credit opportunities, 4) computer science and 5) equity within our education system.

We know that implementing the NGSS standards with fidelity will mean students will do more analyzing, modeling, designing, investigating, and constructing of arguments that relate science to their lives and potential STEM careers. Characterized as a new vision for science education that emphasizes teaching and learning in "three dimensions," NGSS represents "something new or different."

For NGSS to really take hold will involve establishing, maturing and evolving a robust education system that addresses the multiple contexts in which the implementation of NGSS will take place. We know that the success of NGSS implementation will be impacted by:

1. District, school and community culture;
2. Decision-making (from the state to the classroom);
3. Commitment to the equity issues inherent in NGSS implementation;

4. Tangible factors that impact implementation efforts, such as
    a. Accountability,
    b. Instruction & instructional resources,
    c. Leadership,
    d. Financial resources,
    e. Professional development, and
    f. Partnerships.
5. Intangible factors, such as
    a. Critical mass,
    b. Adaptation,
    c. Perception,
    d. History of science education locally and statewide,
    e. Beliefs about teaching and learning, including beliefs about students' ability to learn, and
    f. The quality of what ultimately gets delivered to students.

A major challenge for NGSS implementation is to influence, shape…perhaps transform…the way people think and act when it comes to the "idea" represented by the Next Generation Science Standards. Staying within our "swim lane" (also known as our K-12 mission – lead the development of state policy, provide effective system oversight of public schools, and advocate for student success), the SBE is developing a plan for communicating about NGSS.

<u>Washington State Board of Education - NGSS Communication Plan</u>

1. Our objective is to leverage existing and nascent communication efforts to advance and amplify the successful implementation of NGSS and continued sustainability of high-quality science education in the state of Washington.

2. Our current set of partners include:
    a. Ready Washington
    b. OSPI
    c. AESD (Association of Educational Service Districts)
    d. WSAC
    e. WA STEM
    f. (You) STEM Education Innovation Alliance

    We'd like to broaden the net moving forward, and include:

    g. Higher education
    h. NextGen Teacher Preparation Project (WWU, CWU, EWU, WSU, UW-T, SPU, PLU, etc.)
    i. Businesses
    j. Others

Our strategy is to work with those partners listed thus bringing the collective advocacy needed to support NGSS implementation.

3. Our primary audiences will be:
    a. District and school administrators and school boards
    b. Legislators

4. Our secondary audiences will be:
    a. Science teachers
    b. Families and students
    c. Community stakeholders

5. Key information provided to audiences:
    a. WA STEM 2017 voter survey results regarding beliefs about the value of high quality STEM education;
    b. Examples of tangible benefits of high-quality science education aligned to NGSS;
    c. Closing equity and opportunity gaps and strong NGSS implementation are inseparable, but, to date, NGSS implementation has been uneven, leading to inequities;
    d. NGSS and career and college-readiness in WA are tightly linked;
    e. Increase awareness of NGSS resources, grants, etc.
    f. Information on Washington Comprehensive Assessment of Science Education (WCAS) will be provided, but will not be the primary focus of this communications effort.

6. Key NGSS-related messages:

    Your 2018 STEM Education Report Card mentioned several interesting statistics that we wanted to keep in mind when creating NGSS-related messaging.

    1. That nationally, Washington ranks first for business by CNBC, with the nation's fastest growing economy, and second in concentration of STEM jobs.

    2. Recent surveys of employers show common workforce concerns across the state: that many graduates lack key soft skills and communication proficiencies; and that students need more opportunities for work-based learning→both of these align with themes built into NGSS standards.

    Some of our key NGSS-related messages include:

    a. Every student can be scientifically literate;
    b. Embracing diversity enhances learning;

c. 1) NGSS includes the critical thinking and communications skills that all students need for postsecondary success and citizenship; 2) An ever increasing number of students need a set of desired workforce skills for an increasing STEM-capable workforce; 3) and finally a smaller number of students will still be needed to pursue advanced degrees in STEM to advance the frontiers of science, technology, engineering and mathematics.
d. NGSS weaves together three dimensions: disciplinary core ideas, science and engineering practices, and cross-cutting concepts;
e. NGSS includes the opportunity for: 3D science teaching and learning; rigor, relevance, workforce development; and business, community and school engagement;
f. STEM helps students in other subjects and in life (a perfect partner); and
g. Connecting science learning to students' interests and experiences.

7. Key Date(s)

    a. Soft launch mid March-early summer for school and district administrators
    b. Hard launch event early fall/back to school event
        i. Press release, launch event, webpage, posters disseminated to schools, release of videos, etc.
    c. March 5 (Lacey), May 8 (Yakima), June 20 (Seattle), July 10 (Spokane) SBE community forums
    d. Relevant meetings, workshops, conferences?
        i. Your input is welcome!

8. Communications Channels and Vehicles
   We have a very small grant to support the beginnings of a communication plan. We would like to coordinate with our partners (Ready WA and others) in seeking additional grants to support this work.
    a. Webpage build-out
    b. Social media
    c. Posters/one pagers
    d. Short videos
    e. Events
    f. Visits with editorial boards across state

9. We invite you all to attend our State Board of Education March 5th community forum focused on NGSS in Lacey, from 5:30 – 7:30 p.m. at the SPSCC Lacey Event Center. Please join us!