The Open Universe

A periodic investigation into Vermont Science…

VERMONT AGENCY OF EDUCATION

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Welcome to The Open Universe, a periodic investigation into Vermont Science. In this issue, we'll be discussing the role of Crosscutting Concepts (CCCs) of the Next Generation Science Standards (NGSS) and then we'll dive into equitable practices of science education. To finish up, we'll do some learning together around interdisciplinary science curriculum and instruction.

Next issue, we will learn more about the Disciplinary Core Ideas (DCIs) and discuss the role of performance assessments in the science classroom.

Getting on Board with Crosscutting Concepts

For many, the complexity of the NGSS comes from the interweaving of the CCCs with the Disciplinary Core Ideas (DCIs) and the Science and Engineering Practices (SEPs). Merging content with scientific practice is not particularly new as traditionally, science curricula focused on content and inquiry.

But the CCCs sit with equal footing in the NGSS, alongside the DCIs and SEPs. It is equally important. No longer should pieces of scientific facts, science equations and concepts be taught disjointedly. The CCCs function to create a conceptual framework to help students organize new ideas and help them draw connections between different content areas and practices.

For more information about how to incorporate the CCCs into science instruction or to learn more about the CCCs, please visit:

- STEM Teaching Tool 41
- NGSS: Score Ideas and Crosscutting Concepts (video)
- Bozeman Science

All Standards, All Students

Across the nation, student demographics continue to change, and educators are seeing increased student diversity in their classrooms. However, achievement gaps in science continue to persist. The NGSS have been designed to support equitable science instruction but for this to be realized, implementation efforts should capitalize on learning opportunities while being mindful of the demand it puts on non-dominant student groups.

The National Research Council's *Framework for K-12 Science Education* and the NGSS shared the vision that all students would have access to high quality science learning opportunities. The *Framework for K-12 Science Education* indicates that an achievement gap largely occurs from inequitable opportunities to access science learning. For many students, placement into science courses start with the placement of math courses first. Thinking that math is a gateway for higher levels of science is in error; the NGSS is built to encompass the Common Core Math and ELA Standards.

All Standards, All Students (cont.)

So how do we align ourselves with more equitable practices? The NSTA recommends the following:

- Attune your eyes, ears, minds, and hearts to students' diverse sense-making repertoires as intellectually generative in science.
- Actively support students using their sense-making repertoires, funds of knowledge, and experiences of 21st century life as critical tools in engaging with SEPs.
- Engage students in understanding how scientific practices and knowledge are always developing as part of human cultural activity, and how their own community histories, values and practices have and continue to contribute to science.
- Use students' cultural perspective to make their learning experiences more engaging and meaningful to learners.

For more information about equitable practices in science education, please visit appendix D from the NextGenScience website or take time to look through some of the tools that are offered at STEM Teaching Tools website.

Research Study: Why Teach Science with an Interdisciplinary Approach: History, Trends, and Conceptual Frameworks

When discussing the merit of integrating science disciplines in American middle and high schools today, it's important to understand the history and research that has occurred around interdisciplinary teaching and science education.

Until the Renaissance, all science fell under the umbrella of "philosophy." Names like Aristotle, Socrates, Pythagoras, Plato, Aristarchus- each contributed in one form or another to science and math. Differentiation of natural science disciplines occurred in the Renaissance because it provided a robust way to organize stores of knowledge that had become almost unruly. The division of knowledge into different disciplines was accelerated by reductionism- a belief that larger systems could be explained by breaking it down into smaller, simpler components.

There was a resurgence of an interdisciplinary focus in education with researchers like John Dewey, Stanley Hall, William Kilpatrick, etc. who all advocated for the needs and interests of children being established in curriculum and instruction. However, curriculum integration in schools faded after the launch of Sputnik in the 1970s. Current research has brought the idea of integration back around, indicating that students would benefit from integrating science disciplines. The NGSS has specifically brought in the CCCs to encompass the intertwined features of scientific knowledge and an interdisciplinary understanding of science. Integration of science disciplines facilitates higher-order thinking, provides more meaningful learning experiences to students and reflects the true nature of science, since science phenomena are complex and are not usually isolated in one discipline or another.

Though the research indicates that cross discipline education is best for students, discipline-based classrooms are still the norm in many middle and high schools. While interdisciplinary teaching is built upon the well-established content knowledge from disciplinary science, education experts have suggested that interdisciplinary connections can make learning easier, more realistic, and more useful by asking students to use the skills and knowledge associated with other science disciplines.

To take a more in depth dive into this study, please visit Why Teach Science with an Interdisciplinary Approach: History, Trends and Conceptual Frameworks.

How much would the Milky Way Weigh if the Milky Way Could be Weighed?

Just this past week, astronomers announced that they had used data from the Hubble Space Telescope and the European Space Agency's Gaia satellite to determine the most accurate measurement of our Milky Way's mass: a whopping 1.5 trillion solar masses. Consider that one solar mass is the mass of our sun- $2x10^{30}$ kg.

Surprisingly, only a small percentage of our mass comes from the 200 billion stars and the supermassive black hole at the center of the galaxy (weighing in at an impressive 4 million solar masses.) Most of our galaxy's mass comes from dark matter.

- How Massive Is the Milky Way?
- Hubble & Gaia Reveal Weight of the Milky Way: 1.5 Trillion Solar Masses
- Evidence for an Intermediate-Mass Milky Way from Gaia DR2 Halo Globular Cluster Motions (Research)

The Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST)

The Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) is the highest recognition that a K-12 mathematics or science (including engineering and computer science) teacher may receive for outstanding teaching in the United States.

This year's award will be going to outstanding 7 to 12 teachers.

The award recognizes excellence in teachers who develop and implement high-quality instructional program that is informed by content knowledge and enhances student learning. The National Science Foundation (NSF) administers PAEMST on behalf of the White House Office of Science and Technology Policy.

Some of the awards recipients receive:

- A paid trip to Washington, D.C., to attend recognition events.
- A $10,000 award from the NSF.
- An opportunity to build partnerships with colleagues across the nation.

Consider applying or nominating an outstanding Vermont educator today! For more information, please visit the PAEMST website. **Deadline to apply is May 1, 2019. Nomination period has been extended to April 1, 2019.**

Events and Announcements

Drones for Environmental Mapping

UVM is looking for motivated high school students that would be interested in applying for their UVM Summer Academy to learn more about drone technology and applications. Please visit the UVM Summer Academy website for more information or contact Jarlath O'Neil-Dunne at Jarlath.ONeil-Dunne@uvm.edu.

Events and Announcements, (cont.)

NGSS Instructional Toolkit Workshops for K-12 science teachers

The Vermont Energy Education Program (VEEP) is offering a series of one-day workshops for teachers who are ready to add more hands-on energy education into their curriculum. Workshops will be offered March into May in different parts of the state. Teachers will experience how high-leverage instructional practices benefit learners, and explore the equipment in a VEEP materials kit to support their specific grade-level needs.

To see the full list of dates, get more info, and register, please visit the VEEP website.

Governor's Institute of Vermont

Any enthusiastic Vermont 9th-11th grader is invited to join the Governor's Institutes of Vermont for their best summer yet!

Talented and motivated artists and learners will spend 1-2 weeks completely immersed in a topic they love, work alongside industry-leading professionals and experiencing life on a college campus. Plus, it's tons of fun! For more information, visit Governor's Institute of Vermont online.

Envirothon 2019

Would you like to help your students explore environmental issues and gain practical knowledge and experience in natural resource management? The Vermont Envirothon helps students focus on Vermont's environmental issues related to aquatics, forestry, soils, and wildlife resources through real-world learning in a teamwork environment. Vermont Envirothon is co-sponsored by a variety of agencies and organizations working in natural resource conservation. The program provides an opportunity for hands-on field experiences guided by resource professionals.

Click here for more information or to register.

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