Margaret A. Holzer, Ph.D.,
National Earth Science Teachers Association
mholzer@monmouth.com
(732) 868-0901

Co-author:

Susan Meabh Kelly
American Association of Physics Teachers
susan.meabh.kelly@ttu.edu

Infusing Energy Topics into the K-12 Curriculum

Keywords: Next Generation Science Standards, curriculum

Abstract

As our population grows, so does our need for natural resources, including additional sources of energy. How will we fill this need? New technologies and improvements of current technologies will secure our energy future, so long as we have the creative minds to develop these innovations. Energy education embedded in K-12 education will assist in developing energy literacy, and inspire our next innovators. Fortunately a model of how to incorporate energy education into science, math, and language arts curricula has been developed. The Framework for K-12 Science Education (National Research Council, 2012), and subsequently the Next Generation Science Standards (NGSS) (NGSS Lead States, 2013) provides educators with pathways to infuse natural resource management and sustainable actions into their curricula. The former document can be viewed as a synthesis of twenty years of research in science education and the learning sciences, and latter document translates this synthesis into a set of student performance expectations, all of which will prepare students for college, career and citizenry. Connections to energy education can be found throughout the NGSS. Embedded in life, physical, and Earth and space science disciplinary core ideas, energy is a crosscutting concept as well as disciplinary core idea giving it prominence in the document. For example, energy is a fundamental concept in all three domains – physical science, life science, and Earth and space science, and connections to energy as a resource is a natural application of the fundamental concepts behind energy. For example, middle schools students are introduced to energy of motion and energy transfer, both of which can be applied to an understanding of mechanisms behind hydroelectric and wind energy. Our external source of energy is the sun, and in the life sciences, students are introduced to the process of photosynthesis to capture the sun's energy, and then explore how the energy is transferred in living systems. Within the domain of Earth and space science, students explore weather and climate to understand how energy is transferred throughout the surface of the Earth system. They follow this up by investigating sustainable sources of energy, and the viability of each source, including solar, hydroelectric, wind, biofuels, to name a few.

Science and engineering practices serve as the methods for learning about these disciplinary core ideas, and therefore a student may be designing a prototype to harness and transfer energy, they may be asking questions and seeking answers following their own designed lab, collecting and analyzing data, or they may be evaluating competing design solutions. Additionally, students apply crosscutting concepts such as cause and effect, systems and systems models, and energy and matter as a way to connect what they are learning with other topics. This integration of disciplinary core ideas, science and engineering practices, and crosscutting concepts into lessons leads to what is called "blended" learning whereby students are engaging deeply in the topics at hand as well as developing key scientific and engineering skills. Furthermore, students are provided the opportunity to contextualize the topics they are learning when they solve real-world problems. The NGSS also makes explicit connections with Common Core Mathematics and English Language Arts (ELA) standards by identifying ways to integrate the various math and ELA standards into the NGSS performance expectations. Teachers can easily collaborate with colleagues from those domains to create a rich learning environment where students benefit from natural integration of topics.

As spelled out above, K-12 energy education guided by the NGSS can assist in developing energy literacy. The NGSS are presented in a learning progression style, which means that teachers see the developmental progression of knowledge across grades, and they can use this when creating formative and summative assessments as a way to ascertain the level of understanding students have attained before moving on to another topic. In regards to energy education, these learning progressions guide the development of grade-level appropriate energy related lessons and units, filled with enticing topics to incite our students to think about a sustainable future. For example, discussions about our energy future are filled with complex topics touching upon all areas of science, math, and ELA as well as connect with societal costs and benefits. Following the learning progression layout of the NGSS, grade-level appropriate projects tying in all of those aspects of sustainable energy choices may be designed. Additionally, when these lessons connect students to their local energy challenges, the students engage at a deeper level in order to solve their local problems while applying scientific practices such as engaging in arguments from evidence.

The availability and use of energy resources impinges upon many aspects of people’s lives. Personal and ethical decisions and a range of socio-scientific issues, such as impacts of fossil fuel use on current and future societies, are prompted by information presented in a variety of media formats. Evaluation of reports and proposed energy resource initiatives requires the ability to understand and apply the conventions of scientific argumentation. In this context, argumentation refers to the making of evidence-based claims, and the articulation of how and why the evidence (data) supports the claims.

As energy issues become increasingly prominent in media reports and local decision-making, it is critical that those who will be most impacted by these changes – young people – have greater ability to understand and engage in scientific argumentation. Recent national and state education initiatives (NGSS, Common Core, Revised AP and SAT exams) have placed greater emphasis on evidence-based argumentation. These shifts can be leveraged to improve the quality of evidence-based argumentation in K-12 classrooms.

In order to facilitate these instructional shifts, it is wise to leverage prior state initiatives. For example, for the past ten years every physical science teacher in Connecticut's public high schools has implemented a state energy resource task (CSDE, 2012). This task can be modified to integrate opportunities for argumentation. A new course website provides the foundation for students to investigate challenges associated with past and present energy resource initiatives. Thoughtful integration of research-based instructional practices, such as writing frames (Wray and Lewis, 1997) and cooperative learning (Eichinger et al, 1991; Herrenkoh et al., 1997) ensure successful outcomes. In New Jersey, an NGSS state, model curricula were developed to assist teachers in their transition to the NGSS. Within the curricula written for high school biology, chemistry, physics, and capstone Earth & space science, energy and sustainability play a prominent role in connecting students to the core ideas about energy resources, the science and engineering practices needed to explore our options, and the crosscutting concepts that assist students in making sense of the content. Within the model curricula units, exemplary tools and methods have been identified to engage students and facilitate learning. However, additional NGSS congruent materials would provide teachers with an array of materials which could be modified to fit their teaching needs.

Connecting K-12 educators to exemplary resources that effectively increase student learning in the area of energy education need not be a challenge when nationally recognized venues for dissemination are employed. For instance, the Climate Literacy and Awareness Network (CLEAN) is an ideal clearinghouse of vetted teaching materials where teachers could effectively designed NGSS congruent lessons and units around energy. The American Association of Physics Teachers, National Science Teachers Association and National Earth Science Teachers Association are deeply immersed in science education, and promote quality resources to members as they become available. Connecting educators to the excellent resources designed by those gathered at the Energy Education Summit can easily be facilitated by these organizations through their membership base and professional development mechanisms. All of the components are in place to prepare our students for their energy futures; it is only a matter of connecting the components to ensure this vision becomes a reality.