Using Models to Support STEM Learning in Grades K-5:
Examples and Insights from NSF's DRK-12 Program

Thursday, March 15 | 5:00 - 6:00 PM
Presenters: Cory Forbes, Sara Lacy, Brian Reiser, Carolyn Staudt

The National Science Foundation's Discovery Research PreK-12 (DRK-12) program funds innovative research and development to enhance the learning, teaching, and assessment of science, technology, engineering, mathematics (STEM) and computer science in preK-12. The DRK-12 projects featured in this session provide research-based examples of how students can engage in modeling in the elementary grades.

Focus on Energy: Preparing Elementary Teachers to Meet the NGSS Challenge
foeworkshop.terc.edu
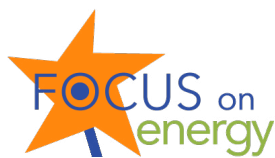
The new science standards identify energy as a disciplinary core idea of science, as well as a crosscutting concept, and expect students to begin learning about energy in elementary school. How can elementary students reason about something they cannot see, feel, or measure directly? Since energy is an inherently abstract concept, the study of energy both demands and is an ideal context for model-based teaching and learning.

The *Focus on Energy* project has developed an innovative approach for teaching and learning about energy in grades 4-5. Through a carefully designed sequence of investigations, students use a common language and set of energy tracking questions to collectively develop, revise, and use a model of energy. In the classroom, we have found striking growth not only in students' knowledge about energy, but in their use of energy ideas to construct coherent explanations of energy flow in contexts ranging from ball collisions to solar panels.

The *Focus on Energy* curriculum includes engaging first-hand activities and representational tools

and is supported by teacher professional learning, online resources, and formative and summative assessments. In June 2018, when the pilot study ends, the curriculum and resources will be available at focusonenergy.terc.edu. In the meantime, more information is available at foeworkshop.terc.edu. (NSF Award # 1418052, 1418211)

Modeling Hydrologic Systems in Elementary Science
corytforbes.com/projects/mohses

The *Modeling Hydrologic Systems in Elementary Science* (MoHSES) exploratory Discovery Research K-12 project, funded by the National Science Foundation, involves three years of research and development to foster and investigate 3rd-grade students' model-based reasoning about the water cycle and how elementary teachers scaffold students' model-based reasoning about water-related concepts. We draw upon an existing modeling learning performances framework to guide development and integration of a long-term conceptual modeling task into the Full Option Science System (FOSS) Water module, collaborative work with five 3rd-grade elementary teachers recruited from diverse institutional settings, and the implementation of a design-based research program. We use classroom

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observations, in-depth interviews with students and teachers, and student artifacts to produce empirical findings, an empirically-tested learning performances framework, and pilot-tested student modeling tasks. These deliverables will ground future work to investigate students' model-based reasoning about hydrologic systems across the K-16 grades and develop an empirically-tested learning progression for students' model-based reasoning about hydrologic systems. The project leverages a partnership involving the University of Nebraska-Lincoln, Michigan State University (MSU), the Iowa Van Allen Science Teaching (VAST) Center, and Grant Wood Area Education Agency (GWAEA). (NSF Award # 1443223)

Sensing Science Through Modeling Matter: Kindergarten Students' Development of Understanding of Matter and Its Changes

concord.org/projects/sensing-science

The *Sensing Science through Modeling Matter: Kindergarten Students' Development of Understanding of Matter and Its Changes* project is developing and researching a technology-enriched curriculum to support learning about matter and its changes at the kindergarten level. We hope that creating a curiosity for science in the early grades is a strong foundation for later STEM learning.

Early learners have significant—and highly untapped—potential for understanding abstract concepts and reasoning in sophisticated ways. Research has shown that technology offers powerful support for conceptual science learning in the early grades.

With researchers from Purdue University and the University of Massachusetts, Amherst, we will develop and research a curriculum supporting early science learning of concepts involving matter and its changes. The curriculum will include dynamic technology-based visualizations and model-based inquiry and help demonstrate the possibilities opened up when opportunities to learn about fundamental science concepts are provided at an

early age. The project will pilot this curriculum with over 300 students at four sites in Indiana and four sites in Massachusetts and investigate student learning. (NSF Award # 1621299)

Supporting Three-Dimensional Science Learning in K-12 Classrooms with NGSS Storylines

nextgenstorylines.org

The Northwestern University *Storylines* project is developing and investigating coherent storylines for the *Next Generation Science Standards*, in which each step in students' learning is motivated by the questions students have articulated or gaps they have identified in trying to explain phenomena. The project works with teams of researchers, teachers, and teacher educators to develop and pilot storyline-based instructional materials for elementary, middle, and high school classrooms. The project investigates how teachers learn to support students' 3-dimensoinal learning as they enact and reflect on their classroom teaching, and how students can develop and use powerful science ideas through their engagement with science practices. (NSF Award # 1020316)

Additional Resources

CADRE, the resource network for the DRK-12 program, curates collections of products and resources for STEM educators that are based on DRK-12 research. The following may be of interest.

CADRE Spotlight on Scientific Modeling

go.edc.org/drk12-modeling

This Resource Spotlight highlights NSF-funded resources, curricula, professional development, and tools designed to support student and teacher engagement in modeling in science classrooms.

Related CADRE Spotlights

- Analyzing & Interpreting Data:
  go.edc.org/drk12-data
- Argumentation, Critique, & Other Discursive STEM Practices:
  go.edc.org/drk12-argumentation
- Online & Blended Professional Development:
  go.edc.org/drk12-pd

Successful STEM Education

successfulstemeducation.org

CADRE highlights a group of promising practices and NSF-funded resources relevant to effective STEM schools and programs, as indicated in the NRC report *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics.*

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