Using Models to Support STEM Learning in Grades 6-12:

Examples and Insights from NSF's DRK-12 Program

Friday, March 16 | 8:00 - 9:00 AM

Presenters: Dan Damelin, Irene Lee, Ilana Schoenfeld

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 secondary grades.

BioGraph

education.mit.edu/portfolio_page/biograph

BioGraph engages high school biology teachers and students in learning experiences that use computational models to build knowledge of biology content, scientific practices, and complex systems. The project has constructed instructional sequences for five high school biology units in the topics of Genetics, Evolution, Ecology, the Human Body, and Animal Systems. Participants use an agent-based modeling platform called StarLogo Nova that combines graphical blocks-based programming with a 3-D game-like interface. Students learn to both use and build models that are dynamic and interactive to develop scientific practices that include collaboration, experimentation, data collection, data analysis, and argumentation. The content and practices are combined with a focus on modeling important features of systems, which is a central *Next Generation Science Standards* (NGSS) cross-cutting concept. These features include: multiple interacting variables, interdependence, emergence, feedback loops, and self-organization. The curricular materials each take two or three days to complete. Working originally with in-service teachers in face-to-face professional development activities, the project team is now working on a professional development delivery model for access to instructional strategies and curriculum at larger scales via the edX online MOOC platform. *BioGraph* is a collaborative, research-based design project created by the Scheller Teacher Education Program and the Graduate School of Education at UPenn and collaborating teacher co-designers. (NSF Award # 1721003)

Building Models

concord.org/building-models

The *Building Models* project is developing a free web-based modeling tool called SageModeler, which makes it easy for students to build systems models that can be simulated. No coding or equation writing is required for students as young as middle school age to engage in the creation and testing of their own models. The *Building Models* project is studying how students learn when they have a tool which allows them to take their mental model of how a phenomenon works and express it in a testable form. As part of the research, the tool is embedded in PBL curricular units and utilizes an iterative approach to modeling which involves multiple cycles of build, evaluate, share, and revise. For more information about the *Building Models* project go to concord.org/building-models, and to learn more about SageModeler and see some curricular units, go to learn.concord.org/building-models. (NSF Award # 1417809, 1417900)

Teachers with GUTS: Developing Teachers as Computational Thinkers through Supported Authentic Experiences in Computer Modeling and Simulation

teacherswithguts.org

Teachers with GUTS prepares middle school science teachers to offer the Project GUTS' Computer Science in Science curriculum during school day science classes.

Teachers with GUTS offers professional development in computational thinking, modeling and simulation:

- 1 week summer intensive workshop
- 1 week summer practicum experience
- Quarterly face-to-face 1 day mini-workshops
- TeacherswithGUTS.org online PD network

Teachers with GUTS research study:

- Design Based Research: focuses on the design, development and testing of resources, models, and tools to support teachers.
- Implementation research: investigates teachers' development as computational thinkers and enactment of the Project GUTS

Teachers with GUTS' uniqueness:

- Prepares teachers as computational thinkers who can use, modify, and create computer models; conduct simulation experiments using computer models; and assess the validity of models.
- Treats computer models as "objects to think with." Inspects the abstractions and assumptions within models.
- Presents coding as a means to create models, not an end in itself.

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(NSF Award # 1503383, 1639069)

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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