UNIVERSITY *of* WASHINGTON

STEM Education

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High school youth in South Seattle apprentice into geoscience research as part of an afterschool program run by the UW Institute for Science + Math Education and UW Oceanography

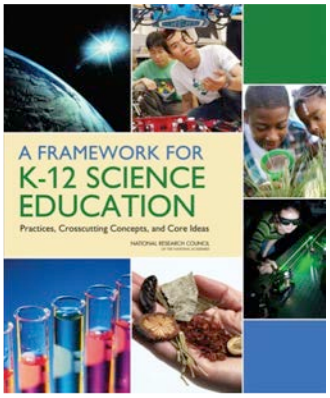
The New Consensus Vision for K-12 Science & Engineering Education

New learning goals should guide K-12 STEM education for the next decade

A new set of ambitious learning goals for K-12 science and engineering education are outlined in the recently released *Next Generation Science Standards* (http://nextgenscience.org/). The standards were developed based on a new consensus vision described in the National Research Council's *A Framework for K-12 Science Education*, which is built upon a synthesis of research on science learning and teaching.

Students need equitable opportunities to learn science for the purposes of college, career, and citizenship. Science is not for the elite, but all K-12 students should have opportunities to investigate core ideas by engaging in disciplinary practices while making connections to crosscutting concepts. The standards call for deeper learning of fewer, core scientific ideas; rich science learning for our youngest learners; and a heightened emphasis on engineering design.

The Washington Office of the Superintendent of Public Instruction (OSPI), in concert with dozens of other states, intends to adopt these new standards. The UW Institute is doing its part in Washington and throughout the country to ensure that K-12 STEM education is informed by the new vision in support of scientific literacy for all. We provide technical assistance to districts and state-level leadership teams and engage in exemplary R&D projects. *See sidebar on page 2 to learn more about the new vision.*



NEXT GENERATION SCIENCE STANDARDS

INSTITUTE *for* Science + Math EDUCATION

For five years the **UW Institute for Science + Math Education** in the UW College of Education has created partnerships – between teachers and school district staff, STEM scientists, informal education staff, and learning scientists – to develop, study and scale equity-focused educational approaches that support science, technology, engineering and math (STEM) learning. To learn more, see:

http://ScienceMathPartnerships.org/

Announcing: Summit on K-12 Science Education May 22 at 3pm & 7pm UW Tower Auditorium

The Institute will host two public events on the University of Washington Seattle campus to provide an overview of the new vision represented in the *NRC Framework* and the *Next Gen Science Standards*. A panel will highlight what is different, present instructional examples, and describe implementation priorities.

Next Gen Science

These free resources can help you learn about the new vision for K-12 science ed

1. Watch a 3-minute Video about the New Vision

Watch this brief video to learn the basics about the new vision.
http://tinyurl.com/FrameworkVideo

2. The NRC Framework Vision

Download and read the new consensus vision for K-12 Science and Engineering Education from the National Academy of Sciences.
http://tinyurl.com/ScienceFramework

3. Watch a Webinar on the Vision

View an hour-long webinar about the new vision for K-12 Science and Engineering Education.
http://tinyurl.com/FrameworkWebinar

4. Download the Next Gen Science Standards

Download the new educational standards for K-12 science education. They are arranged by grade bands across different disciplinary areas.
http://nextgenscience.org

5. Review Online Learning Resources

Explore a range of resources developed by the National Science Teachers Association related to the new vision and standards.
http://tinyurl.com/NSTAresources

The Institute leads curriculum development on an effort called Educurious that engages high school students in contemporary, personally relevant projects with the support of teachers and a network of online volunteer experts who provide feedback to students.

Designing Next-Gen Instructional Materials that Support Ambitious Learning Goals for All Students

The new vision outlined in the *NRC Framework* and the *Next Gen Science Standards* call for instruction that engages students in personally relevant, extended investigations where they use science and engineering research practices to learn disciplinary core ideas while making connections to broad cross-cutting concepts (or themes). New curricula and instructional materials are needed to support students in this kind of learning experience to accomplish the new K-12 learning goals across subjects.

Over the past five years, the Institute has been developing a range of new courses, curriculum units and curriculum adaptations of this kind. All of the Institute's instructional efforts are inclusive instructional models that relate science learning to the cultural lives of learners while providing social and cognitive supports for learning and application of knowledge.

As a central learning design principle, we "position youth as developing STEM experts" who engage in real investigations with the support of teachers and STEM professionals. In *Educurious* (http://educurious.org/), Institute staff partnered with 50 high school teachers to develop year-long, project-based courses in Intro Biology and English delivered on a technology learning platform. We partnered with the Bellevue School District in the *Agency Curriculum Project* to redesign second and fifth grade commercial science kits to take learning principles about cultural relevance and active knowledge construction into account. The *My Place in Puget Sound* curriculum supports high school and middle school students in place-based investigations of the chemistry of water systems and linked community-based action projects that examine behaviors that impact the Puget Sound. These materials have been used with hundreds of teachers working with thousands of youth supported by hundreds of STEM professionals.

Supporting Teachers in Shifting Classroom Practice

An artificial line dividing "research" and "implementation" has often been drawn at the classroom door. Institute projects move back and forth across this line. We work with teachers to design practices and refine them through implementation in the classroom. We are focused on supporting teachers to shift their instructional practice, systematically documenting the results in the classroom, and feeding results back into the process.

In the U.S. Department of Education i3 project, Institute staff collaborate with teacher-led curriculum design teams of 3 to 7 teachers in Bellevue School District as they work to re-organize curriculum around sustained problems. Our efforts to support shifts in classroom practice take several forms. In some cases we are embedded researchers at the table with design teams, supporting the integration of research findings and new policy expectations into curriculum. In other cases we do fieldwork with teachers and students. For example, in an effort to help teachers plan curriculum tasks that elicit and build upon student knowledge and experience, Institute staff convenes focus groups with students to discern students' personal connections to the subject matter in their science courses. The findings are then synthesized for teachers to work into curriculum, which is in turn implemented across classrooms with the support of our research staff.

Creating Afterschool Programs to Apprentice Girls into Science

Research shows that informal learning environments can uniquely help youth from non-dominant communities engage in powerful science learning and come to identify with science (see the NRC *Learning Science in Informal Environments* volume for details). However, more research is needed to better understand the learning processes associated with different communities.

Through a collaboration with UW Oceanography in the College of the Environment, the UW Institute has launched an effort to study the ways youth of color, mostly girls, can apprentice into the scientific work of chemical oceanography. The afterschool program, now in its third year, is scaling to sites in South Seattle schools.

Undergraduates and graduate students at the UW, currently learning how to run afterschool programs, will serve as role models for middle school youth as they explore aquatic chemistry and consider science majors and careers. Middle school students learn about the chemistry of Puget Sound and the impact that human decisions have on water systems. Over the next three years we will continue to expand the program to serve many more youth and UW students.

Designing Instruction as "Cascades of Practices"

The new vision of K-12 science and engineering education seeks to engage students in eight core disciplinary practices – as they learn core ideas and make connections to cross-cutting concepts. In instruction, the eight practices can be sequenced in different, overlapping ways as a "cascade of practices" to engage students in extended investigations (Bell et al., 2012).

A sample investigation might involve:
Develop and pose a testable scientific question (Practice 1)
↳ Design a study and collect associated data (Practice 3)
↳ Analyze and interpret those data (Practice 4)
↳ Revise a model based on data analysis (Practice 2)
↳ Represent & communicate results to an audience (Practice 8)

Children in an indigenous early childhood program engage in science investigations across multiple settings

Designing Indigenous Early Childhood Science Education

Improving science education and early childhood education are increasingly higher priorities in education reform. How these efforts will impact Indigenous communities is not always clear. In an effort to harness these movements in positive and community-driven ways, the Institute through a collaborative project with the Menominee Nation, the Chicago Native community, and Northwestern University, has been developing early childhood science learning environments, in both formal and informal settings.

These projects are designed to support and facilitate Indigenous children, families, and teachers to develop innovative science learning based in Indigenous ways of knowing. The learning environments that have been developed are based in "relational pedagogies" and have focused on developing children's sense of "Living in Relations" with all things by exploring these connections in places beyond their classrooms.

At the Chicago partner site, the American Indian Center of Chicago has developed a program called *Little Ones* where they have been developing age appropriate curricula on grassland, prairie and wetland habitats. As a foundation for classroom activities, children and their families participate in weekend inquiry events at local forest preserves and participate in community driven restoration efforts at a local site.

A unique aspect of the restoration site is the presence of prairie crayfish, which are burrowing land dwelling crayfish. While not an indicator or keystone species, prairie crayfish are thought to be important symbionts for healthy grasslands because they irrigate soil and their burrows are used for a variety of reasons by other species.

Seen above, children in *Little Ones* are busy finding evidence of prairie crayfish through examining burrowing holes. Children and families connect their inquiries across context in these "field experiences" resulting in children's extended inquiry into complex phenomena in ecological systems. Further, children have been developing their observing and narrative/explanation skills.

Researchers have been studying children's complex reasoning patterns and are interested in understanding how extended inquiries across settings have supported rich sense-making and emergent science practices aligned with the new science *Framework*. These studies are demonstrating important cross-cultural variation in cognitive development and the complexity of early science learning.

Rigorous Research on STEM Education – Free Download

The National Academy of Sciences / National Research Council publishes the most reliable consensus reports on STEM teaching and learning. See our compiled list of NRC reports here:
http://tinyurl.com/STEMreports

Teachers and Researchers Collaborate to Scale Innovations in Teaching

Sustained improvement in STEM education will require significant shifts in practice, including how researchers and practitioners generate and share knowledge. In contrast to the ubiquitous "research-to-practice" model, the Institute is advancing an effort to integrate researcher knowledge with practitioner wisdom. Researchers and practitioners will work shoulder-to-shoulder to weave together creative solutions to leading problems of instructional practice. With the support of a five-year NSF grant, Institute staff and partners – the Exploratorium, CU-Boulder, Education Development Center, TERC, Inverness Research and SRI International – will study various strategies for the integration of research and practice.

Locally, the Institute has initiated collaborations with Seattle and Renton Schools, focusing on implementing the new vision of science practices defined in the *NRC Framework* and *Next Generation Science Standards*. Together with classroom practitioners the Institute will develop and study tools and classroom strategies that can be used at scale. Up next, the Institute will launch a related initiative to work with tribal communities across Washington to support their implementation of the new vision.

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All young people should be able to decide their futures.

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