All Students, All Standards: Instructional Strategies Institute

Research to Support High Impact Instruction in Science

Research has identified that **science instruction** needs to engage all students with a broad array of natural phenomena, support rigorous intellectual work, and facilitate full immersion in scientific and engineering practices over long periods of time. Such practices include a broad range of intellectual habits—asking questions, developing and using models, analyzing data, and constructing explanations from data. Thus science practices are not synonymous simply with "hands-on" activity. In a review of the literature on science learning and teaching, Windschitl and Calabrese Barton (forthcoming) identify three common patterns of what they call "ambitious" science teaching, or teaching that "aims to support all students in engaging deeply with science" (p. 3).

***The first pattern involves carefully framing the students' relationship with the intellectual work at hand**, including:*

- teachers having high expectations of students and supporting these expectations in a range of ways;
- students engaging in scientific practices; and
- teachers giving students increasing responsibility for assessing their own understanding and evaluating progress toward important goals.

***The second pattern involves anchoring teaching and learning activities around specific concepts and topics** by:*

- focusing instructional units on subject matter relevant to students' lives, interests, or curiosity;
- coupling important science ideas with extended investigations of complex phenomena;
- making the explanation of the "hows" and "whys" of scientific phenomena a priority as a learning goal;
- building coherence across learning activities and among the bigger science ideas featured in the unit of instruction; and
- interweaving the development of science skills with the development of conceptual knowledge.

***The third pattern involves teachers carefully mediating students' learning activity** by:*

- identifying clear learning/participation goals and designing individual activities through which to reach these goals;
- adapting the progression of experiences to learners' current needs;
- designing instruction that uses the diversity of students' ideas and everyday experiences as resources to further all students' understanding;
- using supports and symbols to engage students in scientific reasoning, discourse, and other interactions; and
- using classroom discourse for a variety of purposes—for example, to make students' thinking visible, reinforce the norms of science talk, prompt sense making and reasoning, "seed" conversations with new ideas, make confusion public, and position young learners as competent knowers of science.

While some might think such an ambitious view of learning is beyond the reach of all students, careful research has demonstrated that challenging instruction is possible if teachers have a clear vision of their goals, well-designed lessons and materials, and—most important—the professional knowledge and skill required to teach to these high standards.

*Adapted from National Academies of Sciences, Engineering, and Medicine. (2015). *Science Teachers Learning: Enhancing Opportunities, Creating Supportive Contexts*. Committee on Strengthening Science Education through a Teacher Learning Continuum. Board on Science Education and Teacher Advisory Council, Division of Behavioral and Social Science and Education. Washington, DC: The National Academies Press.

Instructional Shifts in Science

Moving from less of…	Moving to more of…	Resources to Support Instruction
Rote memorization of facts and terminology	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based reasoning and arguments.	CER Framework Question Formulation Technique STEM Teaching Tools Think-aloud
Learning of ideas disconnected from questions	Systems thinking and modeling to give context for the ideas to be learned	STEM Teaching Tools Teacher Modeling Student Modeling
Teachers providing information to the whole class	Students conducting investigations, solving problems, and engaging in discussions with teachers' guidance	CER Framework STEM Teaching Tools Problem-based learning
Teachers posing questions with only one right answer	Students discussing open-ended questions that focus on the strength of evidence used to generate claims	Question Formulation Technique STEM Teaching Tools CER Framework Think-aloud Socratic Seminar
Students reading textbooks and answering questions at the end of the chapter	Students reading multiple sources, including content-related magazine and journal articles and web-based resources; students developing summaries of information	STEM Teaching Tools Think-aloud Teacher Modeling Science Notebooks
Pre-planned outcomes for "cookbook" activities	Multiple investigations driven by student's questions/interests with a range of possible outcomes that collectively lead to a deep understanding of established core ideas	STEM Teaching Tools Question Formulation Technique Student Modeling Problem-based learning
Worksheets	Student writing in journals, reports, posters, and media presentations that explain and argue	STEM Teaching Tools CER Framework Student Modeling Science Notebooks
Oversimplification of activities for students who are perceived to be less able than their peers	Provisions for support so that all students can engage in sophisticated lessons and practices	STEM Teaching Tools Think-aloud Teacher Modeling Socratic Seminar

Rigor, Relevance, Relationships

Meeting the "Just-Right Challenge"

- "Teaching for Rigor: A Call for a Critical Instructional Shift" Robert Marzano
- Habits of Mind from Costa and Kallick
- Providing Feedback Video featuring Dylan Wiliam
- Formative Assessment Video from Dylan Wiliam

Creating Relevancy

- The Importance of Classroom Structure from Association from Middle Level Education
- Top 12 Ways to Bring the Real World into Your Classroom from teachhub.com
- How to Make Learning Relevant to Your Students from www.opencolleges.edu

Building Relationships

- Educational Leadership "The Key to Classroom Management"
- Teaching Tolerance "Building Relationships in the Classroom"