The Inquiry Project

An IMD Learning Progression

TERC and Tufts University

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Summary: TERC and Tufts University are developing a learning progression in scientific inquiry about the nature of matter. This effort is resulting in a research-guided, coherent system of curriculum, assessment, and professional development to support a progression of learning in grades 3-5 that provides a foundation for understanding the atomic-molecular theory of matter in later grades.

Central questions:

- What do young children think about matter, material kinds, and their properties?
- What understandings about matter at the macroscopic level are important?
- What kinds of mathematical knowledge and representations are important?
- What kinds of metaconceptual knowledge are needed to support inquiry and theory building about matter?

Rationale:

If middle and high school students are to achieve more than a rote understanding of the atomic basis of materials, they need to emerge from their elementary years with a well-stocked toolbox of careful observations, experimental skills, mathematical abilities, and habits of mind. Considerable effort in our first past has focused on determining the contents of that toolbox as well as a compelling rationale for introducing the tools and concepts in particular ways.

Our discussions have been informed by the complementary insights of the education researchers, curriculum developers, teachers, and scientists, on the Inquiry team. We have agreed that the essential elements include:

- Distinctions between objects and materials
- Mass, volume, and density
- Measurement, including techniques, tools and uncertainties
- Invariance of mass under various transformations
- Gases as a form of matter
- Reasoning from evidence
- Modeling and comparing models with experiment
- Graphical representations of relationships between quantities

We have begun evaluating which tools elementary students already possess, and how best to begin assembling the toolkit in the third grade.

Major Achievements of the First Year:
The major achievement was to identify the "well-stocked toolbox" of observations, skills, and habits of mind we wished to provide students with. Our actions include:

- The crafting of learning and teaching goals for grades 3-5
- The development of a curriculum structure with embedded inquiry and assessment, and the preliminary development of a sequence of investigations for grade 3
- The development of assessments, interview procedures and protocols and data base tables regarding students' understanding of: the divisibility and granularity of matter and number; atoms and molecules; length, area, and volume; weight, size, and density; water displacement; balance scales; constancy under deformations (clay) and rearrangements (blocks); what constitutes matter; transformation of material kinds; and sweetness as an intensive quantity.
- The initial collection of data: two-hour interviews with 23 control group students from the partner schools.
- Collaborative work and professional development with teachers and leaders from our partner schools

Expected Products:

- A **baseline study** using a small set of assessments for grades 3-5 in our test-bed schools to measure current "starting" points within the learning progression.
- An articulated series of **instructional materials** for grades 3-5 that use a cycle of inquiry to develop ideas of measurement and modeling, change and conservation, and scale.
- **Formative assessments** that are embedded within the instructional materials to help make students' thinking visible to students themselves, teachers, and researchers.
- Teacher **professional development** that uses formative assessment as a window for helping practitioners to further their own understanding of science inquiry and the nature of matter, and to develop pedagogical strategies for supporting students' learning. Emphasis is placed on the use of science notebooks and classroom discussion.
- A 2.5 year **longitudinal research study** in grades 3-5 with multiple teachers in two test-bed schools that uses extensive classroom intervention and observation, as well as videotaping to study the progression of learning.
- Integration of all the aforementioned components into a **framework** that will help prepare the science education community build coherent systems of articulated curriculum, assessment, and teacher professional development for K-12 science.