Grant R305F100007
Year of Study: 2013

Title: READI for science: promoting scientific literacy practices through text-based investigations for middle and high school science teachers and students
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Citation: Greenleaf, C., Brown, W., Goldman, S. R., & Ko, M. (2013, December). *READI for science: promoting scientific literacy practices through text-based investigations for middle and high school science teachers and students*. Prepared for NRC Workshop on Literacy for Science, Washington, D.C.
Strand of Work: Design and Design-based Research on EBAIMs

Purpose and Questions Investigated
Middle and high school students are capable of high level literacy and science performance, but their current opportunities to learn how to engage in these practices are limited. They are therefore profoundly inexperienced with the kinds of academic literacy and science reasoning practices envisioned in the new Common Core State Standards and the Next Generation Science Standards. Despite the synergistic overlap of CCSS and NGSS, neither set of standards provide an instructional roadmap for organizing instruction to provide learners with opportunities to learn the knowledge, skills, and competencies needed to achieve the outcomes specified by the standards.

In this paper, we introduce an instructional approach we are taking to integrate reading and writing with science inquiry and in so doing provide adolescent learners with opportunities to engage in the literacy practices of science at developmentally appropriate levels. READI text-based investigations seek to create contexts for science learning that position science knowledge as tentative in nature and encourage students in questioning, sense making and knowledge building, an orientation to science and science learning that is largely absent from today's science classrooms. Placing students at the center of text-based inquiry in science requires re-socializing students to actively construct meaning with science texts and to reposition science texts as resources for inquiry.

Research Context or Methodology
To help science teachers navigate this sea change, as well as to build our understanding of what it entails, Project READI has engaged partnering science teachers in ongoing Teacher Networks and collaborative Science Design Teams to develop and implement text-based investigation modules. One way we have worked to build the insights and pedagogical repertoire teachers will need to mentor their students in evidence-based argumentation from multiple science sources is by inquiring deeply into what teachers themselves do as readers and thinkers to derive meaning with complex science texts of varied kinds. These texts might include science explanation and exposition in scholarly journals as well as the diagrams, data arrays, mathematical expressions, and graphs that convey information. Another way we have engaged science teachers is through ongoing collaborative design and implementation of text-based investigations. By deliberately inviting teachers to co-design modules and pedagogies of text-based investigation with us, we have both drawn from and built teacher expertise.

General Statement of Findings

We learned from documentation of initial attempts by collaborating teachers to conduct text-based investigations that we needed to foster a change in the learning ecology of the classroom to support this work. That is, classroom norms for intellectual work, close reading, and collaboration had to be established from the first day of class. Text-based investigations could not merely "drop in" to existing traditional instructional environments. To implement text-based investigations, teachers needed to learn new ways of working in the classroom. Ongoing professional development to make particular instructional approaches stronger and more salient was a clear necessity for teachers to support effective text-based investigations. Likewise, documentation of initial efforts revealed that students needed to learn new ways of engaging with texts and science. These experiences with teachers and students caused us to redouble our co-design work with science teachers to focus on generating new instructional and material supports to address these needs.

We documented a great deal of progress in teachers' implementation of text-based investigations and evidence-based argument in science. A close analysis of instruction in one high school science class demonstrated a radical shift in pedagogy toward science inquiry as the focal point of instruction and away from absorption of science information and facts from lecture and powerpoints. Student learning was mediated entirely by textual resources with text-based discussions and collaborative sense making of the science content. This stood in stark contrast to what is typical in science instruction, and what was typical of this teacher's instruction up to this point.

We have documented evidence of the promise of this approach in student learning, as well. We are seeing that students' annotations on science texts increase in quantity and quality with experience in text-based investigation, moving from no evidence of thinking on the page, to indicators of increasingly meaningful science inquiry processes. Their constructed models increasingly reflect the relevant aspects of a causal explanation, for example, linking three aspects of an explanatory model for malaria: elements of the system, interactions, and aggregate effects. Analysis of these data suggest that more time and experience with the close reading and modeling tasks is correlated with better performance on the assessment. We have some evidence, then, that experience with text-based investigation is helping both science teachers and their students develop literacy in science, knowledge about science concepts, and valued inquiry practices of science such as modeling and explaining phenomena.

Implications

The theory of change on which we based Project READI stipulates that teachers mediate the opportunities that students have to learn. The history of efforts to re-form classroom instruction is replete with evidence that efforts to change educational practice through the introduction of new standards, assessments, materials, strategies, or anything else for that matter are ineffective and unsustainable without investing in building the capacity of classroom teachers by providing opportunities for them to learn how to support student learning. Our collaborative design work, and our partnering teachers' implementations, support this theory of change. We envision that robust disciplinary argumentation based on multiple sources will require ongoing professional development accompanied by

material supports and worked examples in multimedia formats that can be accessed, discussed by networks of teachers, and reflected on in the context of teachers' own ongoing efforts to implement text-based investigations in science.

Acknowledgments
The work we draw on in this paper was done by the Project READI Science Design Team. In addition to the authors, members of the Science Design Team are MariAnne George, Gina Hale, Katie James, Ariana Jaurequy, Rachel Letizia, Katie McIntyre**,** and Ursula Sexton. The research reported herein was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305F100007 to University of Illinois at Chicago. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.