Developing and Implementing a Reading Models Mini-Unit to Support Evidence-Based Argumentation in Science

Project READI Technical Report #22

March, 2013

Updated March, 2016

Mon-Lin Ko, Will Brown, Cynthia Greenleaf, Susan R. Goldman, Rebecca Sela, Elizabeth Childers, and Adriana Juareguy

PROJECT READi

inquirium

Northern Illinois University

NORTHWESTERN UNIVERSITY

UIC UNIVERSITY OF ILLINOIS AT CHICAGO

WestEd

Citation for this Report: Ko, M.; Brown, W.; Greenleaf, C., Goldman, S, Sela, R., Childress, E., & Juareguy, A. (2013). *Developing and implementing a reading models mini-unit to support evidence-based argumentation in science.* Project READI Technical Report #22. Oakland, CA: Strategic Literacy Initiative, Wested. Retrieved from URL: projectreadi.org

The authors would like to acknowledge William J. Pluta, Clark A. Chinn, Ravit Golan Duncan, and Brian J. Reiser as well as the following teachers who served as collaborative members of the Project READI science team: Carolyn Aguirre, Marilyn Stewart, Joanne Zachariades, Katie McIntyre and Rachel Letizia.

Please send us comments, questions, etc.: info.projectreadi@gmail.com

Project READI was supported by the *Reading for Understanding (RFU)* initiative of the Institute for Education Sciences, U. S. Department of Education through Grant R305F100007 to the University of Illinois at Chicago from July 1, 2010 – June 30, 2016. The opinions expressed are those of the authors and do not represent views of the Institute or the U. S. Department of Education.

Project READI operated as a multi-institution collaboration among the Learning Sciences Research Institute, University of Illinois at Chicago; Northern Illinois University; Northwestern University; WestEd's Strategic Literacy Initiative; and Inquirium, LLC. Project READI developed and researched interventions in collaboration with classroom teachers that were designed to improve reading comprehension through argumentation from multiple sources in literature, history, and the sciences appropriate for adolescent learners. Curriculum materials in the READI modules were developed based on enacted instruction and are intended as case examples of the READI approach to deep and meaningful disciplinary literacy and learning.

Introduction

In the fall of 2012, based on lessons learned from the first iteration modules and their implementations, the Project READI science design team developed a mini-module focused on Reading Models in science. The Reading Models module was implemented in two middle school science classrooms and science design team members documented this implementation. Partnering middle school science teachers in the California Teacher Inquiry Network also implemented the Reading Models module. To make the approach more applicable to a variety of science domains and grade levels, three biology and physiology teachers from the Teacher Inquiry Network co-developed a high school life science version of the Reading Models in science module. These modules share a common architecture developed by the larger Project READI team and are designed to address the Project-developed core constructs of knowledge for science and the student learning goals defined by the project. Moreover, Reading Models is seen as a precursor to other text-based investigation modules, since it introduces the idea of modeling science phenomena as a core practice in science, and the multiple representation systems with which science models can be presented (Goldman, et al., 2016).

Developing a Reading Models Module to Introduce Scientific Models

The Project READI design work for science has focused on modeling and explanation as a science-specific literacy task, asking students to build explanatory models from science information about a phenomenon that is proffered in multiple texts over the course of a unit (see Project READI Technical Report #17 for a detailed description of this approach). Our analysis of the preliminary implementations of the high school MRSA and middle school Water modules revealed that both teachers and students are inexperienced with this kind of task and need increased support to accomplish synthesis of science information from multiple text and data sources. Students are deeply socialized to presenting right answers rather than to using modeling and explanation as a way to refine and revise ideas, in effect, to engage in ongoing construction and critique of their own and others' ideas. Furthermore, the teachers implementing READI science modules reported that students lacked the schema for truly scientific models.

While ambitious, our design focus on constructing and justifying one's explanations and models dovetails with the focus on argumentation, modeling, and explanation in science educational reform writ large. It became apparent from our implementation studies that early introduction of a mini-unit focused on reading scientific models would help set the stage for later modules in which students would continue to develop and justify their models of science phenomena.

To develop the mini-unit, we reviewed the emerging literature from the field focused on argumentation as well as the work focused on building empirical learning progressions for science explanation and science modeling. As a result of that reading, we were introduced

to an elicitation task for students' understanding of science models that was developed by Pluta, Chinn, and Duncan (2011). We requested and received permission to use these elicitation materials in our science design work. READI science design team members analyzed the model criteria elicitation materials used by Pluta, et al. (2011) to find commonalities with our design principles and core constructs and to identify gaps that module development would need to address.

As a result of that analysis, and to address the identified needs of teachers and students from our early implementation of the modules, we augmented the model criteria elicitation task to focus more explicitly on inquiry with science texts, rather than assessment of student ideas alone. Thus, we introduced pedagogical tools and practices for engaging students in close reading of a variety of science texts, including the varied models in the elicitation materials, through teacher and student Think Aloud and discussion routines, in sync with our other science design work and modules and drawing on our prior work (see Schoenbach, Greenleaf & Murphy, 2012; Greenleaf, Hale, Charney-Sirott & Schoenbach, 2007). To this end, we searched for an authoritative text on why and how scientists use models and received permission from Reiser to excerpt a text from the IQWST materials (Krajcik, J. S., Reiser, B. J., Sutherland, L. M. & Fortus, D., 2011). This early unit is designed to put in place early scaffolds for reading science texts (Think Aloud and metacognitive conversations) as well as discourse routines to support ongoing sense-making, and ultimately, argumentation. The resulting Reading Science Models module is available through the Project READI website, Case Library, www. projectreadi.org/lor

Collaborative Design-Based Research as a Development Methods

We conceived of the science design work in Project READI as a type of design based research (Barab, 2006; Brown, 1992; Cobb, et al., 2003) that is particularly collaborative in nature. By engaging science teachers as knowledge generators alongside researchers in the collaborative design team, the research is oriented toward productive mutual adaptation to help ensure that instructional design of project modules are informed by teachers' experiences and expertise, and that the affordances, challenges, and issues teachers and students face when engaging with new instructional practices enter into the process of designing and implementing the text-based investigation approach (e.g. Penuel et al., 2011; Voogt et al., 2015). The collaborative design research was intended to play a dual role of producing new knowledge and improving educational practice.

As the Reading Models module was implemented by design team teachers, a team of two READI researchers attended each day to observe, document, and discuss the lessons. The research team took field notes and audio and videotaped the teachers and student small group interactions during the lessons. After the instruction, the team debriefed with the classroom teacher about any changes of note in the lesson plans and in anticipation of how, if at all, teaching plans for the next day may be adjusted to meet student needs.

These debriefing sessions often included instructional coaching and clarification of lesson activities with the teachers.

Implementation of Reading Models Module in Middle School Science

The Reading Models module was implemented in two middle school science teachers' classrooms over the course of 3 to 4 forty-minute instructional periods. Lessons were documented with AV and field notes. An initial interpretation of observations during the implementation in each classroom is below.

Class 1 (4 day implementation)

- Students had general notion of models helping one *understand* or *explain phenomena* – language to describe this remained relatively the same over the three days. Others had definitions that overlapped with everyday definitions. There was some revision of criteria after day 1: the class went back to revise and cross off some ideas after engaging in discussions and looking at scientific models. List on Day 3 includes that models should visualize/help one picture something, *explain, understand,* and *predict*
- Students were quick to evaluate the model, rather than thinking about reading process used to arrive at such conclusions
    - e.g. when the teacher asked what each model tells us, students jumped right to interpretation rather than attending to aspects of model that helped students arrive at that conclusion
- Trajectory over the 3 days was trying to establish norms for discussion, articulate and refine criteria for good scientific model, using examples of models to compare and contrast what counts as a good model and what questions some models are better fit to answer vs. not
  Class struggled to establish norms for listening to one another – did not yet reach critique or defense of claims. Teacher enacted several strategies to re-voice and redirect talk to students. Continued this into the next unit, the water unit.

Class 2 (3 day implementation)

Over the course of the unit, students seemed to gain basic understanding of what IS and IS NOT a scientific model

- They began to recognize important elements of models, specifically the presence of labels and showing a process, but used these two elements repeatedly in their discussion and did not seem to deepen their understanding beyond these basic indicators.

Much of the instructional time focused on establishing the norms and routines (including reading strategies) of modeling

- Students struggled with the norms and routines of discussion and argumentation, but T actively and repeatedly redirected the students and reinforced the norms. With this support they were able to successfully carry out group discussion of their ideas.

Class discussion focused largely on reading strategies; teacher used a poster that was generated on the first day to scaffold students (many of the ideas on the poster came from T although some came from students).

- This approach worked well and students were able to link the strategies they intuitively used with more formal terms from the list (e.g. questioning, analyzing, connecting), which helped give them the language to talk about their ideas in a scientific way.
- Although the students were given several opportunities to add to or change this list over the course of the unit, they did not do so.
- From the class discussion, it seems that they continued to use the same reading strategies throughout the unit and did not recognize or develop any new strategies as they worked with the texts.
- It seems as though this list may have been too inclusive or well constructed (e.g. went beyond students own understanding) and as a result they were unable to go beyond its initial contents.
- Students seem to use the poster almost as a crutch- relying on the poster to generate ideas regarding reading strategies throughout the unit and rarely doing so without the support of the poster.

Teacher discussed reading strategies and how they differ across types of text.

- When discussing an image, for example, she pointed out that this was a different type of text.
- When students were asked how they read this type of text they successfully articulated their strategies with the assistance of teacher and the poster.
- The instruction (and understanding), however, did not seem to get to the point of articulating differences between reading strategies across text types beyond the discussion of a single example.

Teacher repeatedly used a class consensus approach to gauge student understanding

- Proposed a definition or example of scientific models and asked students to give thumbs up or down to show agreement/disagreement
- This approach worked well in that it made students understanding visible and enabled T to use this simple metric of their understanding to guide subsequent instruction

Development of a High School Reading Models Module for Biology

The High School Biology Reading Models Module builds on the Middle School Reading Models Module described above. In the March 2013 California Teacher Inquiry Network

meeting, three high school biology teachers Rebecca Sela, Elizabeth Childers, and Adriana Juareguy) agreed to collaborate in designing a Reading Models module for high school biology. During this meeting, the teachers began brainstorming about the kinds of models they might include. Adriana Juareguy and READI design team staff brainstormed the types of models critical for in high school biology and shared these thoughts with the other teachers. Subsequently, the three science teacher collaborators / authors identified potential texts for the High School Biology Reading Models Module. Over the next six weeks, the text selections were narrowed and Rebecca Sela agreed to write a draft that was refined over the summer to produce the final set of texts and a student interactive notebook designed to provide ongoing support for student learning about scientific models and science reading.

The final draft features flexibility for the implementing teachers in selecting the particular routines for supporting the close reading of the texts (i.e. think aloud, talk to the text/annotation, and double-entry reading logs). In early Fall 2013, we interviewed Rebecca Sela to document the reasoning behind the specific text choices and to uncover the kinds of teacher knowledge she would draw on to dynamically support student learning. The conversation was audio recorded. We annotated the module with implementations supports drawn from the teacher interview to provide implementation support for others intending to use the module.

The High School Biology Reading Models Module resulting from this work is available through the Project READI website, Case Library, www. projectreadi.org/lor. It is highly similar in its goals and processes to the middle school Reading Models Module. The High School Module builds students' knowledge of the function of scientific models and how to read them and advances all 6 of the Project READI science learning goals. The module engages students with two inquiry questions, 'What are science models?' and 'How do we read science models?' and begins by eliciting students prior knowledge about models. Students begin to build on their knowledge by reading an article about science models and developing a criteria list for what counts as science models. Students then read a text set about predator-prey relationships and use criteria from the article to determine which texts are scientific models. Students then read 3 more text sets and assess which models are better for particular explanatory purposes. With each text are close reading supports and metacognitive conversations to support sensemaking, argumentation and scientific reading-processes.

The science design team used the High School Biology Reading Models Module in the context of the Project READI Science Efficacy Study in 9th grade biology. The Reading Models Module was used to introduce close reading practices during the initial phases of the instructional sequence This module was followed by the Homeostasis module (see Project READI Technical Report #23; Curriculum Module Technical Report CM#28) and the high school MRSA module (see Project READI Technical Report #20; Curriculum Module Technical Report CM#27), both of which used similar material supports to scaffold the reading and reasoning processes to ensure that students would have opportunities to engage in increasingly complex reading and knowledge building processes.

References Cited

Barab, S. (2006). Design-based research: A methodological toolkit for the learning sciences. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences*, (pp, 153 – 172), New York, NY: Cambridge University Press.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, *2*, 141–178.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, *32*, 9 – 13.

Goldman, S. R., Britt, M. A., Brown, W., Cribb, G., George, M., Greenleaf, C., Lee, C. D., & Shanahan, C., & Project READI (2016). Disciplinary Literacies and Learning to Read for Understanding: A Conceptual Framework for Disciplinary Literacy. *Educational Psychologist, 51,* 219 – 246.

Greenleaf, C., Hale, G., Charney-Sirott, I. & Schoenbach, R. (2007). *Reading Apprenticeship Academic Literacy Curriculum*. San Francisco: WestEd.

Krajcik, J. S., Reiser, B. J., Sutherland, L. M. & Fortus, D., (2011) *IQWST: Investigating and questioning our world through science and technology. Middle School Science Curriculum Materials*. Sangari Active Science: Greenwich, CT.

Penuel, W. R., Fishman, B. J., Cheng, B. H., & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation, and design. *Educational Researcher*, *40*, 331–337.

Pluta, W. J., Chinn, C. A., & Duncan, R. G. (2011). Learners' epistemic criteria for good scientific models. *Journal of Research in Science Teaching*, *48*, 486–511. http://doi.org/10.1002/tea.20415

Schoenbach, R., Greenleaf, C., & Murphy, L. (2012). *Reading for understanding: How Reading Apprenticeship Improves Disciplinary Learning in Secondary and College Classroom*. San Francisco: Jossey-Bass, a Wiley imprint.

Voogt, J., Laferrière, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional Science*, 1–24. http://doi.org/10.1007/s11251-014-9340-7