
Studying the Implementation of Text-Based Investigations on MRSA in Middle School Science Classrooms: Lessons from Collaborative Design-Based Research

Project READI Technical Report #21

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Citation for this Report: Ko, M.; Brown, W.; Greenleaf, C., & Goldman, S.R. (2016). *Studying the implementation of text-based investigations on MRSA in middle school science classrooms: Lessons from collaborative design-based research*. Project READI Technical Report #21. Retrieved from URL: projectreadi.org

We wish to acknowledge the partnership of the following science teachers who participated in the READI science design and implementation work of the project: Katie McIntyre and Rachel Letizia.

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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.

Development of MRSA Module for Middle School

Based on the observations and analysis of module enactment in participating middle school science teachers' classrooms, the Science Design Team drafted a module for middle school classrooms that would respond to the challenges we identified and build on the practices of close reading and developing evidence-based models for scientific phenomena. The science content focus of the MS MRSA Module was derived from the HS module developed and enacted in Spring 2012 [See Curriculum Module Tech Report CM #20 Life Sciences: The spread of MRSA, Spring 2012; Technical Report #20 Studying the Implementation of Text-Based Investigations on MRSA in High School Science Classrooms]. We adopted two texts from the HS module and focused exclusively on developing an explanatory model for the evolutionary component of the MRSA phenomenon: how MRSA evolved to become antibiotic resistant.

Prior to the design of the unit, we drafted a "needs analysis", based on a review of the existing literature on argumentation and modeling practices and design-based research aimed specifically to foster meaningful engagement with these disciplinary practices. We also revisited our goals for students' work with texts as a disciplinary practice (see Technical Report X for an articulation of these design principles and goals), and used this twofold lens to craft instructional practices that would continually focus on close reading, scientific modeling, and accompanying meaning-making discussions as disciplinary practices.

Below are several design features of the MS MRSA unit:

- Outlined explicit learning objectives for each subset of texts. Each subset of 3-4 texts is used to achieve a single learning objective. We have also outlined specific goals with respect to 1) close reading for each text and 2) ways of attending to the scientific phenomena, providing prompts to guide teachers in supporting students' work with texts
- Drew on a wide variety of types of texts (video, simulations, written text, bar graphs) throughout the unit and helped students attend to the affordances of different types of representation
- Opportunities to visually represent textual information – creating cause/effect diagrams or mini models (nascent modeling) to support their understanding of phenomena
- Supports for meaning-making with texts and about scientific phenomena:
 - Provided prompts and questions that would position students at the center of meaning-making work
 - Provided prompts that explicitly foster multi-text synthesis
 - Prompts directed both at close reading strategies (i.e. attending to affordances of a particular type of text, making inferences or asking questions about the text) as well as attention to scientific phenomena (i.e. what new information are we learning now about bacteria, resistance, or evolution?)
- Supporting multiple opportunities for modeling and developing meta-modeling practices:

- Scaffolding discussions of what we know from the text and how we want to represent that information
- Opportunities for students to build models independently, share with class, and critique and ask questions about one another's models
- Opportunities for consensus building and revision of models, using textual evidence to clarify and provide explanatory accounts for phenomena
- Built in opportunities for engaging in disciplinary argument:
 - Argument about the phenomena: what is MRSA? Why is it a problem? What do we need to figure out if we want to prevent the rise of resistant bacteria? Students are given the opportunity to argue for a need to explain MRSA as a scientific phenomena and construct the driving inquiry question
 - Argument about fit between textual evidence and the driving question: the interactive notebook contains a chart for students to record important ideas from text and make connections to how it helps them answer the driving inquiry question of the unit and to keep track of what questions students have about the phenomenon as they go along
 - Argument about the merit of alternative solutions: Consequential task at the end of the unit asks students to evaluate 3 alternative solutions, to revisit their textual evidence, and then discuss as a class how these solutions do/not address the problem of antibiotic resistance bacteria

The MRSA module consisted of 7 texts, ranging from an agent-based model simulating the process of natural selection, news reports, epidemiology data, and more traditional textbook materials describing evolutionary processes of different species. The module ended with a Consequential Task in which students ranked 3 courses of action for the MRSA epidemic, and argued for the solution that would best address the rise of resistant bacteria. A pre- and post-assessment, grounded in the related phenomenon of lice developing resistance to pesticides, was designed to assess improvement in students' ability to select and synthesize information across multiple texts to develop an explanatory model. One 6th grade science teacher and one 7th grade science teacher used this module in their classrooms in April 2013. An accompanying teacher module, which included teacher notes for implementation, was also created. See Curriculum Module Technical Report CM #24 for The MRSA module, Teacher edition, Consequential Task, and the Lice pre post assessments are attached.

Implementation of MS MRSA Module

This module was enacted in the classrooms of our two design teachers in Spring 2013. Each classroom provided a unique context for understanding how these materials would be taken up by both teachers and students. The students in the 6th grade classroom had experienced both the Reading Science Models Module [See Technical Report #22] as well as the Water module [See Technical Report #19] prior to the MRSA module. The 7th grade students did not have exposure to either of these modules prior to engaging with the MS MRSA module, but did already discuss the mechanisms for natural selection for other science phenomena. Thus, in the 6th grade classroom, the MRSA module provided opportunities for deepening and widening students' experiences with text-based

investigations. For the 7th grade class, the same module served to introduce students to them. Both teachers enacted this module in April 2013. The module spanned 14 days in the 7th grade classroom and 17 days in the 6th grade classroom. Video recordings and field notes were taken each day in both classes.

We reviewed the Teacher edition with teachers, marking where explicit specific supports for guiding metacognitive and knowledge building conversations were embedded in the module. These supports included opportunities for students to document their evidence from readings, make interpretations and connections to the driving question, and also build and revise explanatory models based on the existing sources. Working in the tradition of design based research (e.g. Barab, 2006; Cobb et al., 2003), we worked closely with them to debrief each day's lesson and make note of the aspects of the materials that were supportive of students' thinking and reading processes, and added additional supports in response to these observations. The in-depth analysis below drew on the field notes and observations obtained from the 6th grade classroom,

In the 6th grade classroom, we observed a marked shift from the student and teacher practices observed in prior modules. Although the teacher continued to model close reading processes, students demonstrated ownership and facility with a subset of these practices at the beginning of the unit. These close reading practices were also widened and deepened as the students engaged with various texts throughout the module. Specifically, students' ability to ask questions, make connections to prior knowledge, and engage in reading as inquiry increased dramatically. This was evidenced by their engagement with texts, the annotations made on the text, as well as the conversations around their reading and thinking process.

The intellectual rigor and disciplinary nature of the classroom conversations also grew. Both in the context of pair, group, and whole class discussions, a more diverse body of students participated in the knowledge building process. Some students were working on the articulation of ideas, while others pushed to make interpretations and claims, and questions that drove the investigation forward and generated a need for further reading. This is a marked change from our initial observations in Katie's class, in which only 3 of what she referred to as her "top students" dominated the classroom discourse. Not only that, the level of interest and engagement was high as well; when asked to discuss in pairs or groups, students stayed on topic, shared questions, and built off of one another's ideas. This is again in contrast to the conversations in prior modules, where students would read what they had written on their paper or engage in conversations about other topics.

In addition to changes in reading and talking, students also took increasing ownership over the modeling process. The development of the causal model in prior units was done with heavy scaffolding from the teacher. The teacher scaffolded (through modeling) an initial starting point for the model and had students work independently and in pairs to complete

their models. When students presented their models, they provided evidentiary support from prior texts quite easily, and sometimes, unprompted. This signaled to us that students were in fact synthesizing the ideas from multiple sources, and using them to represent their understanding of phenomena. In addition to the use of models as synthesizing tools and explanations, they were also used as tools for prompting further questioning, and thus, a need for ongoing investigation. Katie played a key role in problematizing students' models, honing in on what causes the bacteria to become resistant (most students included in their models that the bacteria were becoming resistant, and that antibiotics somehow killed the bacteria, see Figure 1a and b). This included questions like "Does the antibiotic kill all the bacteria?" when students drew that all the bacteria died from the use of antibiotics (see excerpt below). Drawing, presenting, and discussing these models, then, served as a synthesizing and problematizing tool, pushing students to engage in further inquiry about the underlying mechanisms of this phenomenon.

C_S_6_DKKM_04192013_VCO.mp4

19:17

T: so we don't know something about this part (pointing to last part in model) the resistance part. What don't we know about the MRSA bacteria and the resistance part?

Student 1: is bacteria resistant to something?

T: we know that already. Student 2?

Student 2: how *IS* bacteria resistant?

T: can you say that louder?

Student 2: how *IS* bacteria resistant?

T: so we know that bacteria is becoming resistant, but we don't what –

Student 2: how it's *becoming* resistant.

T: so we are going to have to find that out...

(Teacher draws up consensus model based on the individual models Ss shared. After writing up that MRSA becomes resistant...)

28:08

T: Student 2 I'm going to go back to what you said. We're at this point now. Student 3, what did Student 2 say?

Student 3: How is bacteria resistant?

T: So we know it's becoming resistant, but we don't really know...

Ss, in unison: *HOW*

T: okay great – let's go to R7 and page 12 in your notebook...

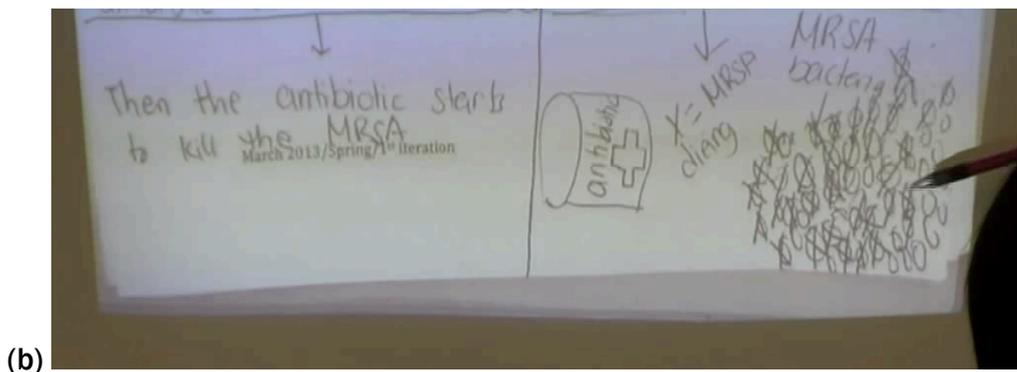
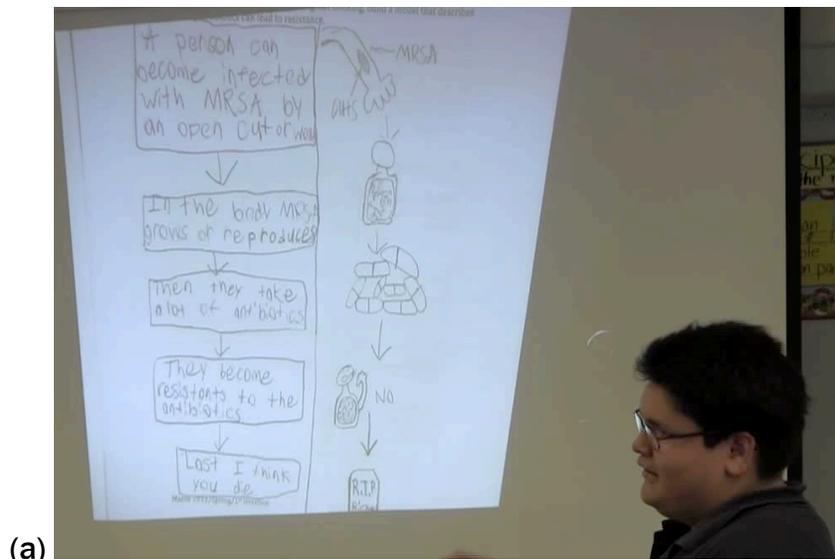


Figure 1. Students' models included that "[bacteria] become resistant to the antibiotics" and the idea that "antibiotics start to kill the MRSA".

The consequential task provided another opportunity for us to see how engagement in reading for understanding could impact students' ability to weigh and decide among alternative courses of action, based on their understanding of the science. A majority of the students voted for the course of action that directly caused the forces driving the bacteria to become resistant, and were able to write and speak about their reasons for doing so.

The pre and post-tests for this unit on the increasing ability for lice to be resistant to pesticides, has not been analyzed in detail. However, we began to look through a subset of these assessments to better understand the range of changes made for a random set of students, from pre test to post test. From this analysis we see that some students have made gains in reading texts more closely and made connections to the principles within the MRSA module, but have not made significant gains on their ability to synthesize those ideas into an explanatory model. Others have made gains in attending to the mechanisms underlying to the phenomena (e.g. attending to resistant and the factors that impact resistance), shifting from the pre test models which focused on descriptions of the

phenomena from the texts. The predominant use of students' prior knowledge was largely absent on both the pre and post-tests that were examined. This cursory analysis helps us develop conjectures about students' uptake of the READI principles and pushes us in developing claims about the different trajectories of progress in students' science literacy practices. We are hoping to build on the analytical tools developed for analysis of the carbon pre posts (See Technical Report #18 for MS Water) to better understand students' use of texts and model-building practices.

References Cited

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