

The Ripple Effect of Epistemological Framing: How A Teachers Moves Shape Students' Framing of Science

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Abstract

This work explores epistemological framing dynamics in a middle school biology classroom and how such dynamics shape student engagement and learning opportunities. Our data sources include student and teacher interviews, classroom videos of three multi-day lessons with a focus on argumentation, and work products collected across one academic year. Our analysis reveals that while the teacher made room for students to generate and negotiate ideas, brief but influential moves emphasizing single correct answers undermined students' sensemaking. These instructional moves, while only occupying a small amount of instructional time, framed students' sensemaking efforts not as a process to seek the strongest explanation from a number of possibilities, but rather to wait for the correct explanation to be revealed from an authority.

The research presented here explores the epistemological framing dynamics (Wendell, Swensen, & Dalvi, 2019) within one science middle school classroom. For this, we trace how the teacher's epistemological framing of argumentation sessions shaped his instructional moves, and how those moves, in turn, influenced students' framing of their work, and the ways in which that framing shaped student learning.

Theoretical Framework

Redish (2004) describes epistemological framing as encapsulating how learners understand their activities in terms of knowledge, reasoning, and learning. It is their interpretation of “what is going on” in an activity. Science education researchers have employed this construct to understand how students interpret classroom cues to make decisions about their classroom efforts (Berland & Hammer, 2012; Hutchison & Hammer, 2010; Scherr & Hammer, 2009). More recently, researchers have turned this lens to understanding the work of teachers (Wendell et al., 2019). Taken together, the research suggests that it is important to recognize how contextual factors influence the ways in which participants frame an activity and thus make decisions about their efforts within that activity.

Recent educational reforms conceptualize science classrooms as spaces where students develop deep understandings of science, both conceptually and epistemically, as they grapple with and socially negotiate their ideas about scientific phenomena (NGSS Lead States, 2013). Key pieces to this conceptualization include the instructional strategies a teacher employs and a teacher's own pedagogical views of scientific instruction. These serve as an epistemological framework that shapes the work that students come to understand as important in science classrooms in terms of knowledge,

reasoning, and learning (Berland & Hammer, 2012; Hutchison & Hammer, 2010; Redish, 2004; Scherr & Hammer, 2009). Prevalent instructional practices, however, are not aligned with the vision of science learning called for in science reforms (BaniLower et al., 2013, 2018; Capps & Crawford, 2013), highlighting the need to understand the framing dynamics that can support reform-based learning.

Methods

Data for this study are drawn from a multi-year professional development project centered on fostering student sensemaking about science through talk. Here we focus on one middle school biology teacher's instructional practice and its influence on his students' engagement. We select this teacher, Jerry (a pseudonym), as our focal participant because we observed that while he provided space and support for his students (N=26) to collaboratively make sense about and develop evidence based explanations for phenomena, surprisingly his lesson wrap-ups centered on the delivery of canonical content knowledge. We wondered about the influence of these wrap-ups on students' framing of their work and their understanding of how scientific knowledge is generated and evaluated.

Data sources included classroom videos, teacher and student work products, teacher interviews that occurred at the start and end of the academic year and before and after each lesson, and open-ended and semi-structured stimulated recall interviews with students at the end of the school year. Classroom videos from three multi-day lessons (i.e., Lesson 1: Cell Characteristics, Lesson 2: Cell Division, and Lesson 3: Natural and Sexual Selection) were analyzed to broadly characterize the different types of activities of each lesson. Following this, we examined salient instructional moves that had the

potential to frame activities towards or away from disciplinary science epistemologies (Berland et al., 2016; Wendell et al., 2019). We further examined culminating discussions to identify patterns of framing. Teacher and student interview transcripts were analyzed using a constructivist grounded theory approach (Charmaz, 2006) to identify patterns and themes related to Jerry's perceptions of his own teaching, his views about science learning, his students' views of their role in the classroom, and their understanding of how scientific knowledge is constructed and evaluated.

Results

The video data revealed that Jerry framed small group argumentation activities as spaces for students to examine somewhat ambiguous data with the goal of reasoning collaboratively about those data as evidence to support scientific claims. He framed these activities as the work of science as he provided opportunities for students to interact with each other around a scientific idea, to collaboratively grapple with and make sense of data, and to negotiate with each other towards a shared understanding of how the data served as evidence to support a claim. On average, students spent 89 minutes (43% of each lesson) engaging in this activity.

However, Jerry's instructional choices in the whole class discussions that occurred after these activities reduced the value of this sensemaking. Instead of orchestrating students' ideas to develop a shared consensus explanation, Jerry consistently unveiled the "correct" answer to the questions. These "unveiling" sessions, which were brief (lasting an average of 8 minutes or 4% of each lesson), revealed that Jerry employed three types of student-teacher interactions and three types of teacher-led statements of conclusion (Table 1).

Table 1. *Types of Student-Teacher Interactions and Teacher-Led Statements of Conclusion*

Student (S) -Teacher (T) Interaction
<i>Broad answer (S) > Revoice (T) > Expands (T)</i> The student responded to a prompt with a broad answer or a general description not based on data. The teacher revoices the response and expands based on evidence.
<i>Answer drawn from data (S) > Revoice (T) > Expands (T)</i> The student responded to a prompt with an answer that included evidence, or the teacher highlighted a statement that included evidence that he had heard students make in an earlier part of the lesson. If the original response was incorrect, the teacher revoiced the response and provided a correct answer based on evidence..
<i>Question (S) > Teacher (T)</i> A student asks a question and the teacher responds with the correct answer.
Teacher-Led Statements of Conclusion
<i>Focal concept</i> The teacher named the focal concept of the lesson or defined the concept.
<i>General trend</i> The teacher described the general trend or answered the question that students were exploring.
<i>Trend drawn from the data</i> The teacher described the trend or answered the question that students were exploring based on evidence.

Student-teacher interactions were sequences in which 1) students responded to a prompt followed by Jerry unpacking the idea further based on evidence from the lesson, or 2) there was a question-and-answer interaction in which a student asked Jerry a question and the teacher provided the answer. The most frequently occurring student-teacher interaction was when a student provided a broad answer or a general description of a trend in response to a guiding question posed by Jerry (Table 2). This response was followed by Jerry's revoicing of the answer before he expanded on the idea situated in the evidence from the inquiry activity. We referred to students' descriptions as "general" in these interactions because they did not draw upon evidence from the data, but, instead, presented a somewhat simple statement. For example, in Lesson 3 when students explored color variations in Venezuelan guppies, Jerry asked "What are some of the trends that you saw in multiple groups?", one student said, "Drab color fish, camouflage,

and avoid predators.” This statement did not draw upon evidence from the data the students had been examining. Instead, Jerry rephrased the student’s idea saying, “The drab coloration helps for camouflage purposes in the areas where predators were present.” He then expands on this statement and situates it in the data when he explains that “in pool one [one of the four pools for which students explored different data], where there is the highest amount of predators, we also saw the highest amount of drab colored males.”

Teacher-led statements of conclusion were moments when Jerry provided vocabulary terms for the concepts being explored or the general trend or answer to the question that students were exploring, which in some cases were situated in evidence from the lab. Giving an answer was the most frequently occurring teacher-led statement of conclusion (Table 2). For example, Jerry told students that “the colorful males will not outcompete the drab males because if the females had preference, they are going to go with the colorful males to reproduce.” This statement, while situated in the context of the lab, did not draw upon the data the students had been exploring.

Our findings show that Jerry’s wrap-ups centered on delivering canonical knowledge and singular explanations of the data; as such they were devoid of any discussion of uncertainties in the data and how evidence is open to interpretation and can support different and competing claims. These culminating whole class discussions, we found, limited students’ understanding of the complex and ambiguous nature of knowledge construction as the discussions tacitly framed science as the unproblematic acquisition of “correct” answers to problems.

Table 2. *Occurrence of Codes During Culminating Whole Class Discussions*

Student (S) -Teacher (T) Interaction				Teacher-Led Statements of Conclusion		
Broad answer (S)	Answer drawn from data (S)	Question (S)	Teacher (T)	Foreshadowing	Generalization	Trend
> Revoice (T)	> Revoice (T)	> Revoice (T)	> Revoice (T)	Conclusion	Conclusion	Conclusion
Expands (T)	Expands (T)	Expands (T)	Expands (T)	Conclusion	Conclusion	Conclusion
Lesson 1	2	1	-	-	3	3
Lesson 2	1	-	4	-	2	2
Lesson 3	7	-	1	2	5	3

Our findings show that Jerry's wrap-ups centered on delivering canonical knowledge and singular explanations of the data; as such they were devoid of any discussion of uncertainties in the data and how evidence is open to interpretation and can support different and competing claims. These culminating whole class discussions, we found, limited students' understanding of the complex and ambiguous nature of knowledge construction as the discussions tacitly framed science as the unproblematic acquisition of "correct" answers to problems. We came to understand that this framing undercut the potential intellectual authority afforded to students when they collectively negotiate and make sense of scientific ideas during small group argumentation activities. Further, the continued enactment of such sequences across the school year set a norm in which students understood their work to be part of an elaborate routine of playing school.

The students' and Jerry's own interviews provided evidence to support these claims. Student interviews revealed that they understood the small group activities to be sensemaking spaces where they could explore data and collaboratively negotiate ideas. Many saw value in the negotiation of these ideas because it made visible different ways

of thinking and informed their understanding; however, they also felt frustrated by remaining uncertainties. They expressed relief that they ultimately received the “correct” answer to mediate some of these frustrations.

For example, one student described that the class would be “given a question” and then they would “try to find an answer and work in groups” to “understand, like, what other points of view” and “look at different ways you could approach and interpret the information that was given.” The student saw this work as doing science “because we were trying to, like, explain why something happens in nature” but he also found it stressful because “we couldn’t agree on [an answer] so we weren’t making as much progress as we would’ve liked.” When asked if he had a sense of closure, he said “Yeah, because he did, uh, Mr. Jerry at the end, he did tell us what, like, the main reason...” When asked if the “correct” answer was always provided, he explained “he’ll [Mr. Jerry] usually shows the question first and then we’ll discuss...afterwards... he hears, like, all our explanations, he’ll show what the correct answer is and then we have to do a write-up for that.” This student’s description aligns with what we observed in the classroom data, in which students were provided space to sense make with peers around data and to negotiate explanations based on the varying perspectives. However, the expectation that the “correct answer” would be provided by Jerry and that this answer was to be the one included in the final product (i.e., the write-up) framed the purpose of science to be the uncovering of correct answers instead of a process of knowledge generation towards a stronger explanation.

Examination of Jerry’s interviews echoed students’ framing of the science discussions as revealed in their interviews and in our own classroom observations. Jerry

identified that small group activities and whole class discussions served different purposes. According to Jerry, small group activities are spaces for “free thinking,” sharing ideas even if they are incorrect, and working together to make sense of ideas—activities he understood to be important to increase students’ interest and motivation to learn. He described these activities as providing some space for uncertainty and wrestling with ideas, but that data should be constrained and the data set not so large that clear and accessible conclusions are unobtainable. His students saw his role in whole class discussions to be the leader and the giver of “correct” information or conclusions. Interestingly, when asked about his own experience in the project’s PD, he described his preference for learning in similar ways to his own enacted practice.

Implication

This work was intended as an exploration of epistemological framing dynamics; specifically, the ways in which these dynamics were influenced by Jerry’s instructional moves and reflected his own epistemological views on teaching science, and how, in turn, they influenced his students’ engagement in and learning about science. While Jerry framed small group argumentation activities as opportunities for collaborative sensemaking about scientific phenomena, from his perspective this sensemaking was important *only* for its affective potential, preparing students to take up the explanations that he would later provide. Jerry’s presentation of a final form explanation at the closure of each lesson, one devoid of students’ rich ideas, supported the students’ understanding of science as consisting of “correct” explanations, echoing Jerry’s own views. This act, one accounting for just a small portion of the overall time invested in a lesson, taught students not to seek the strongest explanation from a number of possibilities, but rather to

wait for the correct explanation to be revealed. This act also worked to prevent students from exercising their own intellectual authority. In this way, we see how Jerry's views about science and science learning exerted their influence through small, brief acts, working in contrast to the richness of students' ideas and negating the possibilities their work could have afforded for their science understanding.

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References

- Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+*. Chapel Hill, NC: Horizon Research, Inc.
- Banilower, E., Smith, P. S., Weiss, I., Malzahn, K., Campbell, K., & Weis, A. (2013). *Report of the 2012 National Survey of Science and Mathematics Education*. Chapel Hill, NC: Horizon Research, Inc.
- Berland, L. K., & Hammer, D. (2012). Framing for scientific argumentation. *Journal of Research in Science Teaching*, 48(1), 68–94.
- Berland, L. K., Schwarz, C. V., Krist, C., Kenyon, L., Lo, A. S., & Reiser, B. J. (2016). Epistemologies in practice: Making scientific practices meaningful for students. *Journal of Research in Science Teaching*, 53(7), 1082–1112.
- Capps, D. K., & Crawford, B. A. (2013). Inquiry-based instruction and teaching about nature of science: Are they happening?. *Journal of Science Teacher Education*, 24(3), 497–526.
- Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Thousand Oaks, CA: Sage Publications.
- Hutchison, P., & Hammer, D. (2010). Attending to student epistemological framing in a science classroom. *Science Education*, 94(3), 506–524.
- NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: National Academies Press.
- Redish, E. F. (2004). *A theoretical framework for physics education research: Modeling student thinking*. In E. F. Redish & M. Vicentini (Eds.), *Proceedings of the Enrico Fermi Summer School, Course CLVI* (pp. 1–63). Bologna: Italian Physical Society.
- Scherr, R., & Hammer, D. (2009). Student behavior and epistemological framing: Examples from collaborative active-learning activities in physics. *Cognition and Instruction*, 27(2), 147–174.
- Wendell, K., Swensen, J., & Dalvi, T. (2019). Epistemological framing and novice elementary teachers' approaches to learning and teaching engineering design. *Journal of Research in Science Teaching*. Online first.