

## ROLES IN EPISTEMIC AGENCY

### “Why aren’t you listening to me?!: Community and Individual roles in students’ epistemic agency in science

Schellinger, J., Gomez, K., Jaber, L. Z., & Southerland, S. A.

Science learning is thought to be best supported when students engage in sensemaking about phenomena in ways that mirror the work of scientists, work that requires that students are positioned as epistemic agents who share, discuss, and refine their thinking to make sense of science phenomena. Using a case study approach, we explore the experiences of one Black middle school girl, Jessie’s, epistemic efforts and the ways in which her group members’ responses to her efforts either supported or constrained her epistemic agency during small group work in two argumentation lessons. We view this work through the lenses of epistemic aspects of scientific argumentation, rhetorical argumentation, and pseudo-argumentation. Our findings show that Jessie’s epistemic efforts were not often taken up by her peers in ways that support her epistemic agency, findings that have implications for student learning and engagement in terms of the epistemic work we ask students to engage in, and the instructional strategies that support this work.

#### Subject

Recent educational reforms have positioned the development of science proficiency as the end goal of science instruction—that is, students should be able to use the tools of science (concepts, ideas, and practices) to construct explanations about the natural world (NRC, 2012; NGSS Lead States, 2013). With this goal, science learning is thought to be best supported by engaging students in sensemaking about phenomena. In short, school science to some degree should mirror the work of scientists (Duschl, 2008)-- work that requires students to not only construct explanations but seek to refine them. This work requires that students are positioned as epistemic agents (Miller et al., 2018; Stroupe, 2014) who share, discuss, and refine their thinking to make sense of science phenomena (Bamberger & Davis, 2013; Berland & Reiser, 2009; McNeill, 2011; McNeill et al., 2006; Smith et al., 2000).

However, as Gonzalez-Howard and McNeill (2020) point out, “True epistemic agency exists only when epistemic authority is realized equally amongst all classroom members” (p. 3). Specifically, all students need to be viewed—by themselves, their peers, and the teacher—as entitled, expected, and worthy of contributing to the [classroom] community’s advancement of scientific knowledge (Zimmerman & Weible, 2018). By examining the relationship between epistemic agency and the construction and critique of knowledge, González-Howard and McNeill (2020) advance the field’s understanding of the role of epistemic agency in learners’ engagement in argumentation. Their findings point to the importance of *students being positioned by the community* as epistemic agents who can participate in knowledge critique and refinement, processes that are central for scientific argumentation. For this to occur classrooms need to be structured so that students “feel that they can be knowers and doers of science and that their participation is valued” (p. 26). As the authors argue, understanding this structure is essential if we are to design classroom environments that are equitable and just.

Because epistemic agency is a dynamic construct negotiated through interactions, examining such agency requires that researchers go beyond examinations of individual learners to consider the interactions between classroom members (González-Howard & McNeill, 2020; Miller et al., 2018; Stroupe, 2014). Research has indeed shown the value in examining different sorts of relationships between actors in a social network, allowing us to visualize characteristics of

## ROLES IN EPISTEMIC AGENCY

interactions related to epistemic agency as students engage in knowledge construction and critique (González-Howard, 2019; Wagner & González-Howard, 2018). Such examinations of social dynamics in argumentation are needed if we are to develop a robust understanding of students' sensemaking in science, and what this sensemaking requires and affords both the community and individual learners. Such an understanding is especially important for promoting the engagement of historically marginalized students who are often positioned as outsiders with minimal power and authority in science classrooms (Nasir & Vakil, 2017).

### Research Questions

In the research presented, we explore the experience of one Black middle school girl, Jessie, in her efforts to participate in sensemaking in a science classroom. We examine Jessie's epistemic agency across two lessons as she and her group members worked to construct claims based on evidence. In particular, we examine Jessie's epistemic efforts and the ways in which her group members' responses to her efforts either supported or constrained her epistemic agency.

We ask the following research questions:

1. What epistemic aspects of scientific argumentation does Jessie engage in during small group argumentation activities?
2. What epistemic aspects of scientific argumentation do Jessie's group members engage in during these same activities?
3. How do these ways of argumentation invite or discourage Jessie's epistemic agency?

### Design

This case study—an approach that allows for an in-depth examination of complex issues bounded by context (Creswell, 2007; Miles et al., 2014)—was situated in a middle-school biology classroom. In our study, we examined Jessie's epistemic agency across small group argumentation episodes bounded by two lessons. The first lesson, *Cell Structure* (Sampson et al., 2014), occurred across four days and positioned students to apply their understanding of cells to develop an evidence-based claim in response to the guiding questions: How should the unknown microscopic organism be classified?. The second lesson, *Mechanisms of Evolution in Venezuelan Guppies* (Sampson & Schleigh, 2013), occurred across three days and positioned students to explore an existing data set and to develop an evidence-based claim from those data in response to the guiding question: What causes color variations in Venezuelan Guppies?.

Here we focus on Jessie (all names are pseudonyms) and her group members, members that were different across lessons. We chose to follow Jessie across groups because we observed that Jessie's ideas were being received in different ways in each group. The first group consisted of two boys, one white and one Asian, named Chad and Lee, respectively, and one Black girl named Kendall. The second group consisted of two boys, one white and one Asian, named Desmond and Tan, respectively, and one white girl named Sandi.

Data sources included videos of small group interactions, which were transcribed, and student work products including worksheets and posters. Small group interactions, viewed through discourse and affect, were the main sources of data and were analyzed to identify moments when **Jessie engaged in epistemic aspects of scientific argumentation**, that is when she:

- *used evidence and reasoning to support a claim,*
- *challenged the evidence and reasoning of others* with competing claims, or
- *examined evidence and reasoning against existing theories* (Berland & Reiser, 2009; Duschl, 2007, 2008; Sampson & Clark, 2008).

## ROLES IN EPISTEMIC AGENCY

We then **examined her group members' ways of argumentation**, coding them as:

- *epistemic* when they aligned with the epistemic aspects of scientific argumentation, such as using evidence and reasoning to support, interrogate, or challenge a claim (Berland & Reiser, 2009; Duschl, 2007, 2008; Sampson & Clark, 2008),
- *rhetorical* when they aligned with persuasive aspects of argumentation in which students took a competitive stance stressing differences of opinions rather than working to understand those differences, or emphasizing the correctness of their claim with minimal regard for evidence, reasoning, or competing claims presented by others (Mercer, 2000; van Eemeren et al., 1996; Walton, 1998), or
- *pseudo-argumentation* when students engaged in the ways of doing school, that is when they worked to satisfy the teacher or focused on completing the task without attention to sensemaking or to coming to a consensus understanding (Berland & Hammer, 2012).

Lastly, we **analyzed how Jessie's group member's ways of argumentation invited or discouraged her epistemic agency**. In this analysis, we attended to discourse (i.e., what was said) and multimodal affective markers (e.g., facial expressions, eye gaze, voice intonation, and gesture) to understand how her peers' responses and interactions invited or discouraged Jessie's epistemic agency.

### Findings and Analysis

Examination of the *Cell Structure* and *Mechanisms of Evolution* lessons yielded different epistemic ways of argumentation that Jessie engaged in as she worked to have her ideas heard and taken up by her peers. In both lessons, her group members engaged in different ways of argumentation that invited or discouraged her epistemic agency. We unpack these findings by describing the ways of argumentation that all group members, including Jessie, engaged in during their small group work and how these engagements supported or constrained Jessie's epistemic efforts and, therefore, her epistemic agency.

#### *Cell Structure - Misalignments: Epistemic, Rhetorical, and Pseudo-argumentation*

During the *Cell Structure* argumentation activity, Jessie and her group (Chad, Lee, and Kendal) examined an unknown organism under a microscope, they discussed whether they thought it represented a plant or animal, and they developed an argument based on evidence (structure of the cell) to support their claim, which they shared on a group poster.

The main interactions during this work occurred between Jessie and Lee who held competing claims. Jessie argued that the unknown organism was a plant and Lee argued that it was an animal. Jessie engaged in the epistemic aspects of *using evidence and reasoning to support her claim* ("Um, the evidence is that there is no cell wall, the cell doesn't have a defined shape. In the picture um, it's an irregular shape, there are four sections here and here and they are spread out."), *challenging the evidence and reasoning of others* ("So the only evidence to saying that this is an animal cell is it doesn't have the cell wall?"), and *examining evidence and reasoning against existing theories* (e.g., Going to her lab notebook and pointing to the characteristics of a plant cell written in her notes that supported her claim.). Lee responded to Jessie's epistemic efforts by employing *rhetorical ways of argumentation*, emphasizing his claim without providing evidence, instead, challenging Jessie to convince him of her claim ("Then give me, then give us evidence, support the evidence, support your claim."). Further, he took a competitive stance, boasting that "I'm the only one that says animal, so they said animal, because they don't have enough evidence." Jessie and Lee were animated in their interactions, with both students having increased intonation in their voices and using body gestures. While both Jessie and Lee exhibited increased intonation, Jessie's intonation and gestures took on characteristics of exasperation and

## ROLES IN EPISTEMIC AGENCY

frustration in which she made statements such as “Give me one substantial piece of evidence that it is an animal and I will believe you but everything you are telling us I argue back and if you could give me one that I can’t argue with then I’ll believe you!”, “If I’m wrong, I’m going to feel like a failure.”, and “You guys are not listening to me!”, while also making gestures such as placing her hands on top of her head and rolling her eyes. Lee, on the other hand, took on characteristics of mocking (“I’m the only one that says animal, so they said animal, because they don’t have enough evidence.” in a chidding voice and an amused expression) and aggression (Grabbing Jessie’s lab notebook and forcefully pointing to her notes).

While Jessie’s *epistemic* and Lee’s *rhetorical ways of argumentation* dominated and were at the forefront of much of the small group work, Chad, the group scribe, who was responsible for recording the group’s claim on their poster, engaged in another type of argumentation. As the scribe, Chad wrote down Lee’s claim, that the unknown organism was an animal, a choice that he acknowledged to the teacher, Jerry, was at odds with his (“*We all think it is a plant and Lee is the only one who thinks it’s an animal.*”), Kendall’s (“*We don’t have a lot of evidence for it being an animal.*”), and Jessie’s claim that it was a plant cell. Chad asked Jerry what he should do with these competing ideas, a question that Jerry responded to by emphasizing that the group just needed to have a claim on their poster (“*Well, you wrote animal so just roll with that, you can just give your side of the story [when presenting].*”), even if they did not all agree on that claim. This was taken up by Chad, as well as Kendall, in the ways of *pseudo-argumentation*, in that they continued with Lee’s claim with no further attempts to negotiate or revise the claim as written because they were following Jerry’s directions to complete the task. During this time, Jessie remained persistent and animated in her epistemic efforts as she continued to argue for her claims. However, when it came time to present the group’s poster, she, as the presenter, shared the argument as written that supported Lee’s argument, but that conflicted with her own. She read the poster in a soft voice, mumbling that she did not agree with the claim. When a student at the poster asked her why she didn’t agree, Jessie quietly stated:

*Okay so basically we looked, they looked for, Lee, Lee looked for everything that were in plants to see if it was in the cell that we are observing and he determined that they don’t have any characteristics.*

Examination of Jessie’s epistemic efforts and her peers’ actions during the argumentation session suggest that the ways in which her peers were taking up or for failing to take up Jessie’s efforts served to discourage her epistemic agency. As an example, Lee’s *rhetorical ways of argumentation* in which 1) he pressured Jessie to convince him he was wrong and 2) he engaged in the work of argumentation as a competition to win by mocking the group for taking up his argument, were at odds with Jessie’s reliance on the scientific norms of argumentation. We see a manifestation of this discouragement as Jessie becomes increasingly more exasperated and frustrated by Lee’s competitive stance, a stance that minimally attended to the norms of argumentation such as supporting his claim with evidence. Indeed, we hear Jessie say on multiple occasions, “Show me your evidence.” Second, Chad’s ways of *pseudo-argumentation* in which he followed the directions of the teacher to produce a written argument on the white board, even though he acknowledged that Lee was the only one who supported the claim that was recorded (that the unknown organism was an animal). Chad’s stance, while initially supporting Jessie’s claim, eventually served to discourage Jessie’s epistemic agency. The group, including Kendall, failed to take up her bid to revise their poster based on her argument, even when she shared evidence and could reason about why that evidence supported her claim. We see this discouragement manifest in Jessie’s presentation of the group’s poster where she is soft

## ROLES IN EPISTEMIC AGENCY

spoken and hesitant to share her contradictory claim, a different intonation and approach from that observed when she was arguing with Lee.

### *Mechanisms of Evolution - Misalignments: Rhetorical and Pseudo-argumentation*

During the *Mechanisms of Evolution* argumentation activity, Jessie and her group (Sandi, Marshal, and Desmond) examined a data set representing different types of predatory fish, different colors of guppies, and different abiotic characteristics (e.g., pool location and turbidity) occurring in the stream environment where the guppies live. The purpose of these examinations was to develop an argument based on these data to serve as evidence to support their claim about guppy coloration, which similar to the *Cell Structure* lesson they shared on a poster.

Sandi and Russell engaged in *epistemic aspects of argumentation*, including using evidence to support their claims, challenging each others' ideas, and working to negotiate a consensus claim. Desmond engaged in *rhetorical* ways of argumentation, emphasizing the correctness of his claim and remaining steadfast in that claim. Many of the interactions during this work occurred between Sandi, who took a leadership role in the group, Russel, and Desmond. Jessie made multiple bids to have her ideas heard during these interactions, bids that were largely not taken up by her peers, acting to discourage Jessie's epistemic agency rather than invite it.

In these interactions, the group's eye gaze and body directionality were largely oriented towards Sandi, the group member that continually challenged Marshal and Desmond's arguments, pressing them to develop a consensus explanation. However, unlike Marshal and Desmond, Jessie's bids to interject her ideas into the conversation were not taken up by Sandi or the other group members. For instance, after multiple attempts to have her ideas heard by the group, interjecting comments that reflected using evidence to support her reasoning, Jessie wrote her ideas on a piece of paper and passed it to Sandi. Sandi was observed glancing at the paper, examining its content, and putting it down before turning back to Marshal and Desmond to continue their discussion. After some time passed, Jessie slid the paper back across the table and then placed her elbows on the table, leaning over, and looking down and away from the group. Jessie made multiple attempts to similarly have her ideas taken up by the group, showing signs of exasperation such as putting her hands on her head, looking away, or seeking out Jerry to share her ideas when they were not acknowledged by the group. Indeed, it was not until Jessie became the scribe, recording the group's argument, that her ideas were acknowledged by the group, inviting her epistemic agency. For instance, when Jessie, with marker in hand, acknowledged that she did not agree with the group's claim, Sandi exhibited concern that her ideas were not being heard. These efforts, however, were cut short when the group made a move to "get something down" on the poster to complete the task (i.e., *pseudo-argumentation*).

### **Contribution to the Teaching and Learning of Science**

The case study presented here points to the dynamic and contextual nature of epistemic agency for students, in this case a young woman of color. Jessie's actions across these two lessons allow us to understand how individual efforts are essential for epistemic agency, but these efforts must be taken up by the large community--in this case, members of her small working group. In many ways, Jessie's continued efforts to be seen as an active contributor to the knowledge construction and critique that she understood to be the goal of both of her small groups is to be celebrated. She was persistent in her efforts for her ideas to be considered by her peers. That persistence is remarkable given the ways in which her peers worked (either actively or by omission) to push her efforts toward the periphery of the group's work. These efforts can be seen as microaggressions that can too easily find a home in argumentation or *pseudo-argumentation* work in classrooms. Microaggressions are "everyday derogations, slights,

## **ROLES IN EPISTEMIC AGENCY**

and invalidations that are often delivered to people of minority or marginalized backgrounds” (Lui & Quezada, 2019, p. 45). We recognize that Jessie’s status as a woman of color played a role in shaping how her efforts to exert her epistemic agency were taken up by or rejected by her peers. This analysis illustrates the interplay of the personal and community in the performance of students’ epistemic agency. Recognition of this interplay is essential for researchers to understand, so that tools and scaffolds can be created to assist teachers in establishing norms to ensure that all students’ epistemic efforts are considered in more robust and responsible manners--knowledge that is essential if the epistemic work we ask students to engage in can become more effective and just.

This material is based upon work supported by the National Science Foundation under DRL #1720587. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

## ROLES IN EPISTEMIC AGENCY

### References

- Bamberger, Y. M., & Davis, E. A. (2013). Middle-school science students' scientific modelling performances across content areas and within a learning progression. *International Journal of Science Education*, 35(2), 213-238.
- Berland, L. K., & Hammer, D. (2012). Framing for scientific argumentation. *Journal of Research in Science Teaching*, 49(1), 68 – 94.
- Berland, L. K., & Reiser, B. J. (2009). Making sense of argumentation and explanation. *Science Education*, 93(1), 26-55.
- Creswell John, W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage Publications, Inc.
- Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, 32(1), 268-291.
- González-Howard, M. (2019). Exploring the utility of social network analysis for visualizing interactions during argumentation discussions. *Science Education*, 103(3), 503-528.
- González-Howard, M., & McNeill, K. L. (2020). Acting with epistemic agency: Characterizing student critique during argumentation discussions. *Science Education*, 104(6), 953-982.
- Lui, P. P., & Quezada, L. (2019). Associations between microaggression and adjustment outcomes: A meta-analytic and narrative review. *Psychological Bulletin*, 145(1), 45–78. <http://dx.doi.org/10.1037/bul0000172>
- McNeill, K. L. (2011). Elementary students' views of explanation, argumentation, and evidence, and their abilities to construct arguments over the school year. *Journal of Research in Science Teaching*, 48(7), 793-823.
- Mercer, N. (2000). *Words and minds: How we use language to think together*. London: Routledge.
- Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook*. Thousand Oaks, CA: Sage Publications, Inc.
- Miller, E., Manz, E., Russ, R., Stroupe, D., & Berland, L. (2018). Addressing the epistemic elephant in the room: Epistemic agency and the next generation science standards. *Journal of Research in Science Teaching*, 55(7), 1053-1075.
- NGSS Lead States. (2013). *Next generation science standards: For states, by states*. Washington, DC: National Academies Press.
- Nasir, Na'ilah Suad, and Sepehr Vakil. "STEM-focused academies in urban schools: Tensions and possibilities." *Journal of the Learning Sciences* 26, no. 3 (2017): 376-406.
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
- Sampson, V., Enderle, P., Gleim, L., Grooms, J., Hester, M., Sutherland, S. A., & Wilson, K. (2014). *Argument-driven inquiry in biology: Lab investigations for grades 9-12*. Arlington, VA: NSTA Press.
- Sampson, V., & Schleigh, S. (2013). *Scientific Argumentation in Biology: 30 Classroom Activities*. Arlington, VA: NSTA Press.
- Stroupe, D. (2014). Examining classroom science practice communities: How teachers and students negotiate epistemic agency and learn science-as-practice. *Science Education*, 98(3), 487-516.

## ROLES IN EPISTEMIC AGENCY

- Smith, C. L., Maclin, D., Houghton, C., & Hennessey, M. G. (2000). Sixth-grade students' epistemologies of science: The impact of school science experiences on epistemological development. *Cognition and Instruction, 18*(3), 349-422.
- Wagner, C. J., & González-Howard, M. (2018). Studying discourse as social interaction: The potential of social network analysis for discourse studies. *Educational Researcher, 47*(6), 375-383.
- Walton, D. (1998). *The new dialectic: Conversational contexts of argument*. Toronto, Canada: University of Toronto Press
- Zimmerman, H. T., & Weible, J. L. (2018). Epistemic agency in an environmental sciences watershed investigation fostered by digital photography. *International Journal of Science Education, 40*(8), 894-918.