Finding Alignment in Framing: Dynamics of Collaborative Disciplinary Engagement in Science

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Abstract

Recent educational reforms conceptualize science classrooms as spaces where students collaboratively engage in disciplinary practices to construct and evaluate scientific explanations of phenomena. For students to effectively collaborate with each other, they need to develop a shared framing of the nature of the science activity and the expectations surrounding their engagement in it. Such framing does not only pertain to the conceptual work but also involves myriad epistemological, social, and affective dimensions. We conceptualize collaborative disciplinary engagement as the process of aligning the group's framing along these dimensions and, we argue, student negotiations to achieve this alignment are in part what initiate and sustain collaborative disciplinary engagement in the science classroom. By focusing on student negotiations, this study builds on existing research on group dynamics involved in science learning and contributes nuanced empirical insights on the nature of student negotiations along the conceptual, epistemological, social, and affective dimensions of argumentation in science. Moreover, the findings provide a proof of concept regarding the key role that student negotiations of framing have in driving collaborative disciplinary engagement. The study findings have implications for research and practice to support learners' productive disciplinary engagement in group work in the science classroom and beyond.

Problem

Recent science education reforms (National Research Council, 2012; NGSS Lead States, 2013) emphasize engaging students in collaborative endeavors where students can co-construct scientific knowledge. Small group work in science classrooms is a valuable context where students have opportunities to coordinate multiple perspectives and negotiate learning and meaning making (Radinsky, 2008; Radinsky, 2000). Research suggests that collaborative work may lead to a better conceptual understanding than isolated individual work (Barron, 2000; Ryu & Sandoval, 2015). But, it has also been shown that simply assigning students to group work does not achieve those better outcomes (Barron, 2003). Collaborative engagement in science not only encompasses active contribution by an individual in group work but also requires acknowledging others in the group as collaborating participants (Barron, 2000). Indeed, certain learning processes and interactional dynamics need to be attended to in order for students to engage productively in group work. Such attention entails that students develop a shared understanding of the nature of the science activity and of the expectations surrounding their engagement in it, that is framing (Scherr & Hammer, 2009).

The framing required in successful collaborative group work does not only pertain to the conceptual work but also involves myriad epistemological, social, and affective dimensions. Recently, scholars have been examining these various dimensions within group work (Authors, 2014; Shim & Kim, 2018; van de Sande & Greeno, 2012). This study aims to build on and contribute to this growing body of knowledge by examining how onegroup of eighth graders navigated the various conceptual, epistemological, social, and affective pulls and pushes that they experienced during an argumentation activity in a biology classroom. By examining how students negotiated these pulls and pushes that arose within their work, we show how tensions and negotiations to resolve such tensions served to drive and sustain the

group's disciplinary work. The research questions addressed in this study are:

- What are key conceptual, epistemological, social and affective tensions that emerged in a small group working on a science problem?
- How did the students negotiate such tensions to achieve alignment in their framing and persevere in disciplinary work?

Theoretical Framework

In order to engage successfully in collaborative science learning, students need to come to a shared understanding of what they are doing (Conlin, 2012). What this entails is for them to align not only their understanding of the conceptual and epistemic goals but also how they will achieve those goals socially in a collaborative space (Barron, 2003; Conlin, 2012; Van de Sande & Greeno, 2012). Since there are multiple ways a task can be interpreted, not all students frame a given task in the same way (Ha & Kim, 2020; Scherr & Hammer, 2009; Shim & Kim, 2018). Students' framing affects what they notice, what knowledge they access, and how they proceed to act. Students might approach the task with different conceptual familiarity (Grooms, Sampson, & Enderle, 2018), different understandings of the nature of the task ("figuring out the phenomenon" versus"constructing a poster" or doing any other school work; Jiménez-Aleixandre, Rodríguez, & Duschl, 2000), and different ideas about the expected social interactions, the roles that each of them are expected to play (expert; mediator; scribe; listener), and the perceived influence that they have in the group (Engle, Langer-Osuna, & McKinney de Royston, 2014). In addition, the task might generate different emotional responses for the students; some might be very curious to "figure out" phenomena while others might just want to finish and move on (Authors, 2014).

Misalignments in students' conceptual, epistemological, social, and/or affective framings (Ha & Kim, 2020; Radoff, 2017; Shim & Kim, 2018) may destabilize their collaboration. When a group's shared framing is misaligned, students may either disengage from the group's work or they may try to negotiate misalignments in their framing to come to a shared understanding. In this study, we are particularly interested in the latter scenario in light of our data from one group that exhibited remarkable tenacity and perseverance in their collaborative engagement despite misalignments in their framing and ensuing tensions they encountered along the way.

Design

The data for this study were generated as part of a larger professional development project geared towards supporting teachers in their attempts to foster student sensemaking about science through talk. The lesson, *Mechanisms of Evolution in Venezuelan Guppies* (Sampson & Schleigh, 2013), occurred across three days and positioned students to explore an existing data set and develop an evidence-based claim from those data in response to the guiding question: What causes color variations in Venezualen Guppies? The data set was ambiguous in nature--there were multiple variables included with marked variation in the data for each. The concepts targeted included natural selection, sexual selection, and the interplay between these mechanisms and how they shape population traits over time and space. The practices targeted included data analysis, explanation, and argumentation. Students spent much of their time during the lesson working in small groups to develop their argument with the goal of creating an argument in the form of a poster to share with their peers.

We present a case study of a small group discussion in an eighth grade biology honors classroom. This group consisted of two boys (Desmond and Marshall) and two girls (Sandi and Jessie). These students were chosen for examination because they appeared to hold different opinions about the data they were working with, generating a series of interesting discussions as they tried to resolve their differences and come to a consensus. The group's interactions were in contrast with the other small groups in the classroom who came to a consensus fairly quickly.

We were interested in exploring what kept this group's discussion sustained for approximately 50 minutes spanning two days to understand the dynamics of student negotiations that contributed to the initiation and sustenance of disciplinary engagement during the course of the lesson.

Drawing on tools from video analysis (Derry et al., 2010), multimodal and behavioral interaction analysis (Jordan & Henderson, 1995; Stivers & Sidnell, 2005), and discourse analysis (Gee, 2004), we analyzed the data to interpret (1) the conceptual, epistemological, social, and affective framing of the group members and (2) the nature of student negotiations towards framing alignments.

Findings and Analysis

In this section, we summarize our key findings regarding the interactional dynamics within our focal group along conceptual, epistemological, social, and affective dimensions of their framing. Due to space limitations, here we provide brief data excerpts to illustrate our claims; in the full paper, we present a more thorough and complete analysis. We show that the students' negotiations of tensions encountered along these four dimensions served as drivers for igniting, reigniting, and sustaining their collaborative disciplinary engagement as they endeavored to achieve alignment in framing.

Negotiation of Conceptual Framing

The ambiguous nature of the data as well as the guiding question pressing students to explore the data prompted students to make sense about different aspects of the scientific phenomenon. This initial round of engagement was marked by periods of individuals reading of the task, with students hunched over and focusing on the worksheet and datasets, followed by a discussion among group members where students proposed different explanations of the trends observed in the data. As they engaged in the task, students in our focal group had different conceptual lines of reasoning about the data. For instance, at one point as the group explored the data to explain what caused trends in the coloration of guppies, two students (Sandi and Desmond) had different arguments; Sandi favored the concept of the turbidity of the water as a potential factor causing trends in the coloration of guppies, while Desmond favored the number of predators. This conceptual misalignment was recognized by one of the students, Sandi, who made a bid to call out the unresolved inconsistency among the participants' claims. She pushed the group to consider more deeply the reasoning behind their choices, by posing the following question, *"So, you think the haziness of the water affects that but do you think the, uh, especially the predatory fish also affect it? And you think that's affected by the upstream aspect?"* Sandi's question reignited the group's engagement as students tried to align their conceptual framing by entertaining the different lines of argument and continuing to grapple with the data, debating which one of the factors best explained the trends in coloration (i.e., turbidity, depth, location, and presence of particular types of fish).

Negotiation of Epistemological Framing

Although initially aligned around their desire to make sense of the problem at hand, we saw a shift in the group's epistemological framing when the teacher (Mr. Jerry) reminded the students of the remaining time. In response, the group members were divided in their epistemological framing, with Marshall and Jessie wanting to construct the poster and Sandi and Desmond persisting in their desire to figure out the phenomenon. This misalignment appeared to cause a tension in the group marked by rich displays of emotions from the students (*Sandi: Wow. I hate fish because of this*, *Jessie: We've been doing this for like, all of class*.) In response, Marshall made various bids to relax the tension by using humor and laughter and trying to persuade Sandi and Desmond to align their conceptual framing ("*We don't have to be right, we*

just have to have a claim and enough evidence to support it"). Marshall's approach to resolving the epistemological tension could have jeopardized the group's disciplinary engagement by moving students away from figuring out the phenomenon towards playing the school game of putting something on the poster. This bid, however, was not taken up by Sandi who persevered in her need to understand the phenomena, thereby sustaining the group's sense-making about the phenomenon at hand.

Negotiation of Social Framing

Although the students shared their ideas with one another, each one of them seemed to take up a distinct social role within the group. Sandi positioned herself as the problematizer of the group. She prompted the group to think about multiple lines of reasoning as well as tried to open up spaces to include multiple voices. At the same time, Jessie made several attempts to position herself as a collaborative contributor. She showed her intention to accept other students' ideas and discuss them as well as question their explanations; however she often did that in a rather gentle hedging manner (*"So maybe..So maybe this part..this part of the stream where there's three and four, maybe that's specifically used for mating and this is just, that's just land.Cause the drab fish really have no purpose if they don't have the, they don't have the colors. They just a a a a food source for the... what's those fish called? Predators"*). Desmond initially positioned himself as being the main content authority in the group. This was indicated by the way he presented his ideas as the correct answer, his consistent and continued reiterations of his ideas, and his unwillingness to consider others' arguments. Desmond ignored Jessie's attempts to contribute by speaking over her or at the same time as she was presenting her ideas.

Jessie however continued to try to socially position herself as a collaborative contributor by attempting to gain access to the conversational floor as well as by using humor ("*Maybe the fish just give up. Fish do that")* or reminiscing about other moments of vexation that they experienced in the class (*"I feel like every time we get data, we don't get like enough. So, It makes it more stressful than it has to be"*). During Day 2, Jessie became more assertive in positioning herself as a valuable contributor. As Marshall was pushing the group to land on an argument and finish the task (*"It doesn't have to be main effects, just go with it. Let's just go with the broad claim"*), the group almost settled with Sandi's conceptual idea (*"Turbidity affects the coloration of fish"*). However, Jessie at that moment made a pronounced explicit bid to challenge the group's conceptual consensus, pressing them to more strongly support the claim with evidence (*"But can we prove that?...No, literally, she has to prove it"*). This bid was taken up by Sandi who recognized Jessie's contribution, which once again reignited the group's engagement.

Negotiation of Affective Framing

As denoted by their animated discussion, voice intonations, and facial expressions, the students were initially excited to figure out the phenomenon addressed in the task and appeared to enjoy co-constructing explanations. As they wrestled to make sense of the ambiguous data, they showed signs of vexation and frustration (rapid speaking, higher tone, deep sighs, giggling, and humor to save face), feelings that kept them engaged in refining their interpretations of the data towards constructing an explanation that resonated with all the members. However, as soon as the teacher reminded the group of the limited remaining time to complete their poster, Marshall's feelings started to shift as he worried about time pressure to complete the task. Marshall showed signs of his worry and some frustration and impatience with the group's continued negotiations to make sense of the data ("*We don't have to be right, we just have to have a claim and enough evidence to support it!")*. However, as the rest of the group continued to debate, Marshall eventually was drawn back into sense-making about the phenomenon and joined the group's animated debate about the various claims.

Contributions

We presented an analysis of the framing dynamics that contributed to initiating and sustaining collaborative disciplinary engagement in a group of eighth grade students. We identified that the students' disciplinary engagement was initially ignited by the ambiguous nature and potential of the task. This initial engagement led to misalignments in students' framing along the conceptual, epistemological, social, and affective dimensions. These misalignments were often recognized by at least one group member and made public through problematizing questions, expressions of uncertainties, and affective displays. Negotiations to resolve the various tensions that arose, we have shown, supported the group's continued disciplinary work. Moreover, our findings highlight that in order for such collaborative engagement to be sustained, at least one group member must recognize such tensions and work to actively address them and be responsive to bids made by other members in service of aligning the group's framings.

Implications and Significance

Given the vision of science education presented in current reforms (NGSS Lead States, 2013), the field is in need of descriptions of how students engage disciplinarily in science as well as an understanding of the dynamics that sustain or cut short this engagement. In this work, we present a compelling case of collaborative disciplinary engagement and highlight the kinds of conceptual, epistemological, social, and affective work that students must do in order to sustain such engagement. Understanding student negotiations along the different conceptual, epistemological, social, and affective dimensions can give us insights into what fosters productive student engagement. Our work will be of importance to NARST members interested in the design of collaborative learning environments that afford all students with opportunities for productive and equitable participation in science learning.

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Literature Cited

Authors. (2014)

Authors. (2016).

Barron, B. (2000). Achieving coordination in collaborative problem-solving groups. *The Journal of the Learning Sciences*, *9(4), 403-436*.

Barron, B. (2003). When smart groups fail. *The Journal of the Learning Sciences, 12(3), 307-359.*

Conlin, L. D. (2012). Building shared understandings in introductory physics tutorials through risk, repair, conflict & comedy. *Doctoral Dissertation*, University of Maryland, College Park.

Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., Hall, R., Koschmann, T., Lemke, J., Sherin, M., & Sherin, B. L. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *The Journal of the Learning Sciences*, *19*(1), 3-53.

Engle, R. A., Langer-Osuna, J. M., & McKinney de Royston, M. (2014). Toward a model of influence in persuasive discussions: Negotiating quality, authority, privilege, and access within a student-led argument. *The Journal of the Learning Sciences*, 23(2), 245-268.

Gee, J. P. (2004). Discourse analysis: What makes it critical?. In *An introduction to critical discourse analysis in education* (pp. 49-80). Routledge

Grooms, J., Sampson, V., & Enderle, P. (2018). How concept familiarity and experience with scientific argumentation are related to the way groups participate in an episode of argumentation. J*ournal of Research in Science Teaching*, 55(9), 1264-1286.

Ha, H., & Kim, H.-B. (2020). Framing Oneself and One Another as Collaborative Contributors in Small Group Argumentation in a Science Classroom. *International Journal of Science and Mathematics Education*, 1-21.

Hammer, D., Elby, A., Scherr, R. E., & Redish, E. F. (2005). Resources, framing, and transfer. In J. Maestre (Ed.), *Transfer of Learning From a Modern Multidisciplinary Perspective* (pp. 89-120). Greenwich, CT: Information Age Publishing.

Jiménez-Aleixandre, M. P., Bugallo Rodríguez, A., & Duschl, R. A. (2000). "Doing the lesson" or "doing science": Argument in high school genetics. *Science Education*, 84(6), 757-792.

Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *The Journal of the Learning Sciences*, *4*(1), 39-103.

Kapon, S. (2017). Unpacking sensemaking. *Science Education*, *101*(1), 165-198.

National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. National Academies Press.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By State*s. Washington, DC: National Academies Press.

Radinsky, J. (2000). Making sense of complex data: A framework for studying students' development of reflective inquiry dispositions. Learning Sciences. *Unpublished Doctoral Dissertation*, Northwestern University, Evanston IL: 349

Radinsky, J. (2008). Students' roles in group-work with visual data: A site of science learning. *Cognition and Instruction*, 26(2), 145-194

Radoff, J. (2017). Dynamics contributing to the emergence and stability of students' Scientific engagement over multiple timescales. *Unpublished Doctoral Dissertation*, Tufts University, Medford, MA.

Ryu, S., & Sandoval, W. A. (2015). The influence of group dynamics on collaborative scientific argumentation. *Eurasia Journal of Mathematics, Science and Technology Education*, 11(3), 335-351.

Sampson, V., & Schleigh, S. (2013). *Scientific Argumentation in Biology: 30 Classroom Activities*. Arlington, VA: NSTA Press.

Scherr, R. E., & Hammer, D. (2009). Student behavior and epistemological framing: Examples from collaborative active-learning activities in physics. *Cognition and Instruction*, 27(2), 147-174.

Shim, S. Y., & Kim, H. B. (2018). Framing negotiation: Dynamics of epistemological and positional framing in small groups during scientific modeling. *Science Education*, 102(1), 128-152.

Stivers, T., & Sidnell, J. (2005). Multimodal interaction. *Special issue of Semiotica, 156*(1/4), 1-20.

van de Sande, C. C., & Greeno, J. G. (2012). Achieving alignment of perspectival framings in problem solving discourse. *The Journal of the Learning Sciences, 21*(1), 1–44.