

Are We Moving toward Equity in Science Talk?: Evaluating Timing and Positioning of Talk Moves

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Abstract

Within the science education reform movement, there have been long standing calls initiated to attend to equity in the science classroom. These calls are sought to de-settle and advance the broad strokes of “equity for all” into deeper, more meaningful actions, considering the way we view equity and how equitable practices unfold in the classroom. Productive science discourse or productive science talk is just one instructional practice used and discussed which leverages students as sensemakers. This study seeks to better understand productive science talk as a practice of equitation instruction. In examining Ms. Savannah’s practice, a high school biology teacher, two major findings emerged around the use of productive talk: (1) pattern of moves to leverage student ideas and (2) timing of moves to stimulate interest or motivation. These talk moves and timing gave insight into talk as both having the ability to hinder and foster student ideas and provide an initial “on-ramp” for students’ voice to be heard, taken up and have accountability in the classroom. This work continues to sustain a call toward attention to equity and a need to evaluate the equity-aligned practices that are fore-fronted in PDs and workshops.

Subject/Problem

The Next Generation Science Standards (NGSS) presents science education as a way to position students in constructing and evaluating scientific explanations through sensemaking to develop an understanding of mechanistic phenomenon through three-dimensional (3D) learning (NGSS States Lead, 2013). This reformed approach positions students to engage in conceptual lifting and “figure out” science instead of “learning about it” (NRC, 2012). Within the reform movement, there have been long standing calls initiated to attend to equity in science classrooms. The Framework for K-12 Science Education outlines the need for all students to have “equitable opportunities to learn science and be engaged in science and engineering practice” (NRC, 2012 p. 28) with access to quality space and equipment, adequate time and teachers to support and motivate students learning and interests. Likewise, the “All Standards, All Students” appendix of the NGSS lays out the need for support, access, and inclusion in the classroom with accountability for economically disadvantaged students, minoritized racial and ethnic groups, students who come from a multi linguistic background, girls in STEM, and students with disabilities (NGSS States Lead, 2013). While these guiding documents address equity more explicitly than previous standards, there is still a lack of central focus on equity in science education (Burgess & Williams, 2022; Jones & Burell, 2022; Patterson et al., 2020; Patterson & Gray, 2019; Rodriguez & Morrison; 2019; Winn, 2018; Tate, 2001).

Equity as reconceptualized by Philip and Azevedo (2017) outlines four discourses of equity that are present in the science education literature: (1) improving students’ achievement and access; (2) increasing students’ interest in and identity with science; (3) broadening what counts as science, and (4) exploring the interaction of science with social movements. While no single definition of equity enjoys widespread privilege this work provides a lens to reorient toward these broader discourses of equity within the constraints of science education. This lens allows us to think deeply about the interplay of the school, community, professional, and political levels. Classroom instruction and teaching practices that lack the integration of ideas and resources brought by students to sense make offer limited ways in which students can

express themselves and cultivate their STEM-identity (Allen & Eisenhart, 2017; Jones & Burell, 2022). In doing so this leads to the perpetuation of the traditional notions within the discipline, due to the lack of new perspectives and ideas (Burgess & Williams, 2022; Carlone et al., 2011; Nasir, 2012), as well as a lack of opportunity for non mainstream students. De-settling of privileged epistemological ways of knowing and thinking is critical for providing the opportunity for students of non-dominant groups to have an on-ramp into STEM spaces and the “doing” of science (Bang et al., 2012). To de-settle and advance the broad strokes of “equity for all” into deeper, more meaningful actions, consideration of the way we view equity and how equitable practices unfold in the classroom is key.

Productive science discourse or productive science talk is just one instructional practice used to provide the “on-ramp” for students’ funds of knowledge to be accessed and leveraged as students sense make about phenomenon. Two decades of qualitative research have led to the development and refinement of moves known as *talk tools* which provide support for teachers to orchestrate equitable and productive discussion (O’Connor & Michaels, 1993; O’Connor & Michaels, 1996; O’Connor, 2001). Encouraging or mandating talk in the classroom does not just simply create an equitable discussion for students to engage in (Michaels & O’Conner, 2015). Teachers who facilitate productive science talk have the ability to deepen student reasoning and understanding while creating a space that helps students to orient to one another and listen carefully to connect ideas (Anderson et al., 2011). With the “doing” of science being a communicative and collaborative aspect of the science classroom, voice must be a part of the reframing of equity. The ideas Fricker (2017) presents on epistemic injustice provide the space to question the access, uptake, and distribution of student voice of the individual and group.

The goal of this study is to use an equity lens to understand the efforts of science teachers to facilitate productive science talk, as part of a professional development experience where an equity driven lens was not explicit. Following Mark and colleagues (2020), we argue that this analysis will allow us to document how reform-minded practices facilitate or fail facilitate equity-minded practices. In this work, we ask **how does the timing of and orchestration of talk moves relate to the use of productive science talk as an equitable tool in supporting students' sensemaking in science?**

Design/Procedure

This research was conducted as a part of a larger NSF-funded study, focused on supporting teachers in fostering student sensemaking through productive science talk (Southerland et al., 2017). The program began in the summer of 2018 with 36-hours of PD structured to meet current recommendations for effective PD (Borko, 2004; Desimone, 2009; Wilson, 2013). The focal participant, Ms. Savannah, attended the summer institute in the fourth iteration of the program with the goal of learning to foster students’ talk in service of making sense and explaining phenomenon, as the literature on science learning speaks of the need to “figure things out” or make sense and explain nature phenomenon, to which student talk is essential. Ms. Savannah continued in the PD program throughout the school year, engaging in four virtual meetings where teachers could come together to reflect on the lesson enactment and decompress on school-oriented issues. Four lessons were audio and video captured during the in-school period, which coincided with the meetings. Key instructional moments that supported or had the potential to support student talk were identified in the field notes by the first author. Each meeting focused on a specific theme that supported the development of teaching practices that foster student sensemaking. The meeting focuses included role of anchoring phenomena, using

student ideas and reasoning, role of evidence, and use of student ideas toward the end goal relating to productive student talk.

Data Collection and Analysis

We examined video observations and field notes of two lessons that Ms. Savannah taught during the 2021-2022 school year as a part of the PD program. The classroom video and audio for both lessons was chunked according to phase of enactment (launch, task implementation in small groups, and whole class wrap up). Next, each lesson was first coded for use of the nine talk moves (See table 1), as described by Michaels & O’Conner (2012). Moments were selected for further analysis to better understand the how and when of productive science talk as an equitable practice in the specific context of Ms. Savannah’s high school biology pre-IB class. Interviews were conducted with Ms. Savannah to understand how she saw herself during the facilitation of productive talk, and its uses to support equitable instruction.

Findings & Analysis

From our analysis two major findings emerged as important in understanding the use of productive science talk as a practice of equitable instruction: (1) pattern of moves to leverage student ideas and (2) timing of moves to stimulate interest or motivation. We found that Ms. Savannah enacted different instructional moves in different sequences and frequencies based on the lesson (Table 1). It is important to note the difference in sequence and frequency between the lesson could be attributed to the sequence of the lessons within the pacing guide for the year as well as the comfortability for both Ms. Savannah and her students in engaging in productive science talk.

Fruit Fly Lesson

The Fruit Fly lesson was enacted across two block periods for a total of 180 minutes. During the lesson almost 50% (n= 40) of the talk moves engaged in inviting students to deepen their reasoning, with 35% (n=29) of the total moves focused on challenging, where Ms. Savannah pushes back on student ideas, or providing space, where she leaves a lingering question that is intended to provoke students in thinking further around their ideas. Counterexamples were used for both this challenging and providing space action that Ms. Savannah used, in doing so she was intending to get students consider the validity of their argument, the data selected, and what data could be used to refute their claims as they engaged in science and engineering practices. Ms. Savannah also leveraged the challenge to position students toward the “on-ramp” for their thinking on and of the experiences they had encountered in their lives that may not be reflected in the data, this “on-ramp” provided access beyond just the student facing materials students had physically.

Ms. Savannah initiated these challenges when questions from students arose, which did not always end in students being positioned to voice their ideas and have equity. For example, Cami, a female latinx student, and Grady, a white male student, called over Ms. Savannah during their discussion on their selected trait being dominant/recessive or sex linked.

[Prior to Ms. Savannah being called over]

Cami: I don’t know who would carry it [the gene] if it sex linked dominant.

Grady: I don’t think its sex linked. The pedigree doesn’t work.

Cami: So, it’s just plain dominant or recessive?

Grady: Maybe it is sex linked? [Cami sighs]

Cami: I’m going to ask. [Raises hand]

[Ms. Savannah comes over after a moment]

Ms. Savannah: Cami, how is it coming for you two?

Cami: We don't know. It's like- it's confusing because couldn't it just be dominant, and recessive how do you know it's sex linked?

Ms. Savannah: Let's see what you've already done. [Looks down on paper] Your pedigree should match the simulation for the number of generations, here you only have the parents. What about the offspring?

Grady: We were trying to do that after.

Ms. Savannah: It might be helpful to do that before. **But what if the trait is incomplete dominance? Have you considered it through your Punnett squares?** {Challenging Idea Talk Move}

Cami: Oh. No?

Grady: Did we need to do all of them?

Ms. Savannah: No, I was just wondering if you had considered it that's all.

[Ms. Savannah walks away]

Cami: Okay so it's incomplete dominance? How do we show that?

Grady: I think it has to change like this [adjust pedigree on white board]

In this episode, while seeming to have the intention to challenge the ideas the students presented and move their thinking forward, the question proceeded to narrow students' lines of thinking as they adjusted focus to only incomplete dominance and the means at which they could evaluate it. The timing of use of the talk move in which students were not certain in their ideas did not effectively move students toward considering alternative explanations or ideas but instead more simply highlighted that their idea was incorrect, effectively shutting down further consideration of the problem and possible resolutions.

These ideas and moves are supported by her end of year interview in which she states that part of her role in facilitating productive science talk is "playing devil's advocate" and "challenging [students'] ideas to help them see if they had thought through all of the evidence provided or collected." Ms. Savannah heavily relied on alternating between challenging students' ideas and providing them time to talk specifically during small group work as she found it the best time to let them "get to think more about the questions I was asking without [feeling] the pressure of if it was the right or wrong answer." In the excerpt above, the students are left with the idea that answers are "wrong" as this pressure to make choices based on teacher discussion sways their thinking. While this was her intent to help students, the example shows that this move sometimes had very different outcomes for students that the teacher intended for.

Guppies Lesson

The Guppies lesson was also enacted across two block periods for a total of 180 minutes. While Ms. Savannah continued to focus more on deepening student thinking, as an overarching goal, her use of talk moves that helped students individually share, expand, and clarify their own thinking followed an interesting pattern, which differed from the Fruit Fly lesson. The use of talk moves time to talk and say more (see Table 1), were used 33% (n=28) of the time and constrained to the beginning and end of the lesson. Ms. Savannah used the two moves in tandem to provide the space to think and then press students on the ideas presented. Wait time was used to position students as *thinkers* and not just *responders*, letting it be understood that Ms. Savannah was not looking for the answer but the reasoning as students approached their problem or an idea around what they were thinking. Students typically (n=9) were given the chance to "sit with ideas" prior to responding and then were pressed into elaborating further.

The use of these questions was helpful during the launch of the lesson, where Kurt, a male mixed-race student, was asked to further his thinking:

Ms. Savannah: So before we get started, you've looked over the table and are going to create your map but what kinds of data do you think could go on your map? {7 seconds of Wait Time} [Hands begin to raise]. Kurt?

Kurt: Maybe the waterfall.

Ms. Savannah: What do you think about the waterfall? Help us understand. {"Say More"}

Kurt: Like the barrier of the waterfall and how the stream goes.

Ms. Savannah: Oh, so maybe putting geographical information on your map?

Kurt: Yeah...like I thought maybe since it's not just about the number of them [guppies] in the ponds but maybe like how they got there has to do with physical things. Like, um, they got stuck or get stuck and can't come down because there is something there.

This excerpt is supported by her post lesson interview and reaffirmed in her end of year talk, as she stated that "[students] sometimes give these great explanations but most of the time I feel like if I don't follow up with another question, we lose it [the momentum] ... It's been hard for me to wait and give them space, it's not ideal at times when I feel like we need to move through but if I push them too quickly... I'll lose them and they'll only worry about what's wrong or right." Ms. Savannah placed value in giving students space, even when the burden of time, something many teachers acknowledge as a barrier or a hindrance in the classroom, is at the forefront of her mind.

Contributions & Impact

The purpose of the professional development that Ms. Savannah participated in was to support teachers in facilitating student talk in the classroom, allowing students to engage in meaningful sense making about phenomena and form explanations about the natural world. The PD supported teachers in their implementation of the nine instructional talk moves (Michaels & O'Connor, 2012). These talk moves are shown to have the ability to both hinder and foster student ideas and provide an initial "on-ramp" for students' voices to be heard, taken up and have accountability in the classroom. This work might be best addressed within the discourse on equity in which the broadening of science is taken up (Philip & Azevedo, 2017). There is a clear space needed to evaluate the equity-aligned practices that are fore fronted in PDs and workshops. By supporting and finding evidence of aspects of tools such as productive science talk and the talk moves, we can hope to move the field further in accessing equity as a core aspect of science education.

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Figures & Tables

Table 1. Nine Talk Moves (O'Connors & Michaels, 2012) with Ms. Savannah Talk Move

Goal	Talk Move	Fruit Fly Lesson		Guppies Lesson	
		Frequency	Overall	Frequency	Overall
Individual students share, expand, and clarify their own thinking.	Time to Talk	15	18.5%	11	12.8%
	Say More	12	14.8%	17	19.8%
	So, Are you Saying...?	2	2.5%	1	1.2%

Students listen carefully to one another.	Who can rephrase or repeat?	5	6.2%	10	11.6%
Students deepen their reasoning.	Asking for Evidence or Reasoning	11	13.6%	18	20.9%
	Challenge or Counterexample	29	35.8%	22	25.6%
Student think with others.	Agree/Disagree and Why?	6	7.4%	4	4.7%
	Add On	1	1.2%	3	3.5%
	Explaining What Someone Else Means	0	0%	0	0%
Total		81		86	

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