

A Study of Teacher Sensemaking about Productive Student Talk in Science Classrooms

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Abstract

One way to support teachers' learning to facilitate the recent reform vision (NRC, 2012) in their classrooms is through professional development (PD). We explored a biology teacher's (Monica) sensemaking during the PD that focused on facilitating productive science classroom discourse to understand her responses to the PD in terms of teaching science by engaging students in productive talk in science classrooms. Using both video and interview data, we analyzed the process of her sensemaking about facilitating (productive) talk during the PD and the meaning she was making of productive talk. Our analysis indicated that Monica participated in sensemaking mostly about her students' participation in talk. Throughout the PD conversations, she rarely focused on what she could do (or could have done) to facilitate student talk without the PD facilitators' pressing. This is supported by our analysis of the interviews with Monica, which showed that the sense that she was making about productive talk mostly focuses on students' contributions to the talk and their accountability to reasoning, scientific knowledge, and sensemaking. These findings provide implications for facilitating teachers' sensemaking around new instructional practices and reforms within PD contexts.

Problem

Recent reform efforts within science education aim to create environments where students grapple with and negotiate participating in making sense of phenomenon using science content and practices simultaneously (NGSS Lead States, 2013). One way that teachers can facilitate students' sensemaking is through the use of talk. Talk is important because it supports students' development of their cognitive skills, allows for disciplinary engagement, and fosters sensemaking (Campbell, Schwarz & Windschitl, 2016). However, implementing lessons focused on creating opportunities for talk is difficult for teachers to facilitate even after participating in professional development (PD) (Sandoval et al., 2018). In an attempt to analyze how teachers respond to what is presented in the PD, researchers have begun using sensemaking as a theoretical lens for understanding teachers' learning and ways to promote it (e.g., Allen & Penuel, 2015; Marco-Bujosa et al., 2017). *The research presented here builds on the previous work in the field and explores one science teacher's process of sensemaking and the sense she made of talk as she participated in PD, where she designed, implemented and reflected on science lessons to facilitate productive student talk in science classrooms.*

Theoretical Framework

Sensemaking is a concept that allows us to analyze how teachers wrestle with what productive talk is and how they might use it in their classrooms. Specifically, we use sensemaking in this study as a framework to understand how teachers organize and give meaning to events in the PD or in their classrooms related to the facilitation of productive talk in science classrooms (Weick, 1995). The idea of sensemaking describes how a person forms an understanding of something unknown (Waterman, 1990). In other words, sensemaking allows us to understand how groups and individuals gain different meanings from the same event. When teachers participate in PD, they join in sensemaking around incoherency between what they are taught in the PD and their practice (Allen & Penuel, 2015). Building on this, teachers can think about what they are learning in the PD in relation to their own context and make the most learning gains (Marco-Bujosa et al., 2017).

Teachers have difficulty implementing lessons focused on talk even after participating in professional development (Sandoval et al., 2018). However, talk is important for classrooms because it allows the opportunity for teachers to understand how a student is making sense of a scientific concept or idea. This idea of talk in service of student sensemaking is built on in the term "Accountable Talk" which is a type of orchestrated discussion focused on supporting student learning (Resnick, Asterhan, & Clarke, 2018). Accountable talk is conceptualized with its three interrelated dimensions: 1) accountability to knowledge, accountability to reasoning, and accountability to the community. Accountability to knowledge requires being held accountable to the disciplinary knowledge and the process of sensemaking. Students are responsible for talking using resources as evidence to support their claims. Accountability to reasoning centers on ensuring that students' ideas are visible. Accountability to community positions students as important stakeholders in building an understanding as a class. Informed by the literature in accountable talk (Osborne et al., 2019; Resnick et al., 2010), in this study, we conceptualized productive science classroom discourse as the kind of talk, which is accountable to learning community, which requires attention to and building on the ideas of others as well as accountable to standards of reasoning and scientific knowledge and the process of sensemaking (Author, 2020).

Design

We used single case study (Yin, 2013) as we explored, in-depth, one of the biology teachers' (Monica) participated in PD in which she engaged in the design, implementation, and revision of science lessons to promote productive student talk in her classrooms. This year-long PD was conducted as a part of a larger NSF-funded research project that focused on supporting biology teachers' facilitation of productive science talk.

This PD was designed using the design features of effective PD (Desimone, 2019; Wilson, 2013). The PD started with a six-day summer institute in the summer of 2018. Teachers were then given a choice to participate in the in-school cycles (Image 1). Each cycle was made up of

1. a design session focused on collaboratively designing a lesson focused on providing students opportunities for productive talk (each teacher in the PD was partnered with another teacher or one of the members of the research team),
2. a teach session where the teacher teaches the lesson they designed and is video and audio recorded, and
3. an analyze session where teachers watch, analyze and discuss 5-10 minute video clips of their own or their colleagues' designed lessons.

As presented in Figure 1, each cycle had a different focus surrounding the theme of productive science talk. Cycle 1 discussed the role of anchoring phenomenon in supporting productive talk, Cycle 2 focused on using student ideas to facilitate productive talk, Cycle 3 centered around the role of evidence in productive talk, and Cycle 4 emphasized using students' ideas towards an end goal.

Monica was purposefully selected for this study to understand the sensemaking of a teacher who participated in a non-traditional education program and chose to teach at a school with mostly minority students. Also, she was the only high-school biology teacher in the PD. Her interest in science began with her love for botany. She obtained a Ph.D. in botany and worked for many years in plant biology. Fifteen years ago, she decided to change careers and completed a non-traditional education program to obtain her teaching certificate. Monica teaches Advanced Placement (AP) biology and International Baccalaureate (IB) Biology in her current school, where she has taught for five years. It is at a public high school in the southeastern United States that is made up of 93% minority students, and 54% of students receive free and reduced lunch. As a part of the PD, the first author collaborated with Monica as her partner to co-design lessons focused on productive student talk. This close collaboration allowed the author to see trends in Monica's sensemaking that were worth examining. For a more systematic exploration of Monica's learning, this study aims to address the following research question: *How does Monica make sense of productive talk in her participation in the PD, which involves design, implementation, and reflection on lessons to facilitate productive student talk in science classrooms?*

Data sources and Analysis

We draw on several data sources to examine Monica's sensemaking: Video-records of Analyze PD sessions, interviews (pre-post teach interviews, and interviews before and after the conclusion of the PD). In our analysis of the PD sessions, we identified instances of Monica's sensemaking about facilitating (productive) talk in video-records of the discussions during Analyze sessions, which provided opportunities for teachers to reflect on and analyze their own and colleagues' video-records of teaching. Informed by Robertson and Richards (2017), we analyzed the process of Monica's sensemaking about facilitating (productive) talk by identifying instances in which she did one or more of the following: raised a question or concern about

facilitating students' talk in science classrooms, explicitly made an effort to articulate the meaning she was making of some aspect of productive science classroom talk, considered aspects of (productive) talk in relation her own context, negotiated something about productive science classroom talk with others in the PD, and/or displayed an affective or identity-laden response to science talk.

We draw on two types of interviews in our analysis. The first set of interviews were conducted before and after the implementation of the co-designed lessons. We began the interview analysis by focusing on the interviews with Monica about the Bird Migration Lesson, because this lesson was designed in the last cycle of the PD. Each of these interviews was approximately one hour long and was recorded using audio recorders and then transcribed. The main focus of the pre-teach interview was to determine how the teacher planned to incorporate productive talk into the lesson enactment. The post-teach interviews focused on how the teacher thought the lesson went in general and in relation to productive talk. The second interview type was the interviews before and after the conclusion of the PD. The pre-PD interview was conducted before the summer PD. The questions that were a part of this interview did not specifically focus on productive student talk and were more general questions about teaching. The post-PD interview was focused on changes she saw in her teaching after learning how to design for and facilitate lessons focused on productive talk. In the analysis of these interviews, we identified instances of Monica talking about productive talk or facilitating talk as these moments reflected the meaning she was making of productive talk, mostly concerning her practice at the end of this year-long PD. We coded instances where Monica discussed facilitating (productive) talk concerning aspects of "accountability to the learning community" which requires attention to and building on the ideas of others, and characteristics of "reasoning, scientific knowledge and the process of sensemaking" which focuses on talk as a way to make students ideas visible and then use them to refine understanding.

Findings

Overall, Monica's sensemaking around the PD focused mostly on her students and their contribution to talk. During the PD session, she mostly *raised a question or concern about facilitating students' talk in science classrooms and displayed an affective or identity-laden response to science talk*. All of these moments were coded in relation to her students. This was supported by the interview data, which showed that when Monica is making sense of productive student talk, she was mostly focused on students being accountable to *reasoning, scientific knowledge, and the process of sensemaking*.

Process of Sensemaking about Productive Talk

As Monica sense made about how she might plan to facilitate productive talk, her focus tended to be in her students and their struggles in participating in talk in her science class. Monica tended to *raise questions or concerns about facilitating students' talk in science classrooms* when she had tried the practice of whole group discussions that the facilitators were suggesting, and it did not work for her. When discussing the idea of providing opportunities for students to revise their work after a round-robin discussion, she says, "They (students) usually end up putting the same stuff back out". Later in the session, she brings up this same idea again by describing a specific lab that she had completed as a part of the PD. She states, "I feel that what they had (on their whiteboard) is what they put up (on the online discussion board)". Monica was able to *consider aspects of productive talk in relation to her own context* when explicitly asked to relate the idea to her teaching. In the moments where *aspects of productive talk in relation to her own context* were coded, one of the PD facilitators would press her to think

explicitly about her lesson. When asked if she would re-teach the lesson she designed again the following year, she begins by discussing the content focus of the lab but quickly changes and begins discussing what she would change "I think it needed just a little more time because there was no wrap up at the end, and then I would have questioned them more on their justification". This happened again later in the conversation, where the facilitator asked her to think about how two lessons she taught were different. She then discussed students' prior knowledge about the subjects, the students' background knowledge, how comfortable they were narrowing down the data, and the student's motivation to get a good grade.

When Monica *negotiated something about productive science classroom talk with others in the PD*, she tended to be sensemaking around her colleagues' videos of their classroom teaching. She used the prompt of her colleagues' video and her colleagues' comments to support her sensemaking about productive talk. One such example is when thinking about how a lesson went and what students might have been thinking about and struggling with as a part of the lesson Monica brought up the idea that "turbidity" may have been a term that students have never heard of or thought about deeply before.

During the PD, Monica *displayed an affective or identity-laden response to science talk* many times, specifically regarding her students. Specifically, she described the feeling of frustration with her students. When asking about how the whole group discussion typically goes in her classes, she describes a moment where "frustration levels were very high". During this moment, students were asked to describe how genetically we know dogs are distantly related humans. Monica describes students throwing out "stupid answers" or things that did not relate to the question being asked to explain genetic relationships. Later in the PD, she describes frustration with students when they are completing their lab reports. This is because she believes that the lab report does not reflect what students know because students do not spend the time needed to complete the assignment to the best of their ability.

Descriptions of Productive Talk

Our analysis of the interviews with Monica indicated that Monica attempted to make sense of what productive talk means and how she might facilitate it in her classroom throughout the PD. Specifically, the interview analysis revealed that Monica describes productive talk mostly in the service of students' contributions and being accountable (or not) to *reasoning, scientific knowledge, and the process of sensemaking* (63% of total codes).

During the initial interview with Monica before she participated in the summer PD, she discussed facilitating productive talk mostly in relation to students' (2 instances, 67%) and the teacher's (1 instance, 33%) contribution to talk by being accountable to *reasoning, scientific knowledge and the process of sensemaking*. One such example is when asked about the relationship between explanations, and argumentation Monica discusses the students' experience in the process of creating an argument as "*Where's your argument going to come from if you don't have anything to back it up? One of the things with science, we can't just say, oh today I think the sky is pink. You know, where is your support, where's your evidence?*".

In Monica's pre and post teach interviews, she continued to describe facilitating productive talk in relation to students' (3 instances, 75%) and the teacher's (1 instance, 25%) contributions to the talk by being accountable to *reasoning, scientific knowledge and the process of sensemaking*. She describes this role as a way for students to analyze data and demonstrate their understanding of scientific concepts. Concerning her experiences facilitating productive talk, she states, "*The overall goal was getting at that, you know, why are birds migrating? Why is this being affected? What's going on? And so that took a little time and then some probing. Um,*

you know, kind of I think, I think in almost every group though, I had to be like, they got to evolution somehow, and then they didn't get to genetics right away until I asked them to define evolution."

The end of the year interview showed some variation. Though Monica again mostly focused on students' (12 instances, 60%) contribution to talk by being accountable to *reasoning, scientific knowledge and the process of sensemaking*, she also discussed students' (5 instances, 25%) *accountability to the learning community*. When thinking back on PD and students' experiences, she discusses that students that generally do not participate in small group assignments join in small group discussions in the labs she designed for student talk. She also discussed being surprised to see that students were engaged and talking about their task even when she was not at the table watching them, *"It was so funny because over the summer watching all of the other labs and when they were videotaping and how all of the lab groups would be working, I just kept thinking, there's no way my kids are going to be working. As soon as I walk away from their lab station. They're going to be doing nothing. But they actually like brought in and we're having those discussions and you could hear it. And it wasn't just the cameras there because fifth period, which didn't have cameras, they were the same way."* When describing her contribution as a teacher to talk, she describes herself as a facilitator of student talk, *"You want them discussing everything, we want them working through the problems, then thinking it, us being more a facilitator and letting them work through it."*

Contributions to the teaching and learning of science and NARST members

As the field is seeking ways to assist teachers in facilitating ambitious instruction in professional development settings, Monica's experience as she sense makes about how to facilitate productive student talk in her classroom give us insights about teachers' learning to develop such ambitious teaching practices within professional development settings. Our analysis showed that Monica's sensemaking around productive talk focused mostly on her students and their contribution to talk. Teachers' sensemaking can be furthered by helping them to see teaching in relation to students' thinking (Author, 2015) and contributions to talk, which could support teachers to relate their actions as tools to support students' productive engagement in talk. PD facilitators can press teachers to think more about teaching in relation to students' thinking (see Author, 2015) and reflect on their teaching about what they can do to better facilitate productive talk in their classrooms. This crucial step of thinking about what the teacher can change in relation to their own practices and context is important to see necessary changes in their practice as well as increased gains in their students' learning (Marco-Bujosa et al., 2017).

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.

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