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Understanding the Development of a Hybrid Practice of Inquiry-Based Science Instruction and Language Development: A Case Study of One Teacher's Journey Through Reflections on Classroom Practice

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Abstract This qualitative case study looks closely at an elementary teacher who participated in professional development experiences that helped her develop a hybrid practice of using inquiry-based science to teach both science content and English language development (ELD) to her students, many of whom are English language learners (ELLs). This case study examines the teacher's reflections on her teaching and her students' learning as she engaged her students in science learning and supported their developing language skills. It explicates the professional learning experiences that supported the development of this hybrid practice. Closely examining the pedagogical practice and reflections of a teacher who is developing an inquiry-based approach to both science learning and language development can provide insights into how teachers come to integrate their professional development experiences with their classroom expertise in order to create a hybrid inquiry-based science ELD practice. This qualitative case study contributes to the emerging scholarship on the development of teacher practice of inquiry-based science

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instruction as a vehicle for both science instruction and ELD for ELLs. This study demonstrates how an effective teaching practice that supports both the science and language learning of students can develop from ongoing professional learning experiences that are grounded in current perspectives about language development and that immerse teachers in an inquiry-based approach to learning and instruction. Additionally, this case study also underscores the important role that professional learning opportunities can play in supporting teachers in developing a deeper understanding of the affordances that inquiry-based science can provide for language development.

Keywords English language learners · Inquiry-based science · Elementary science · English language development · Professional development · Teacher development

Introduction

There has been a growth of theory, research and practice related to recognizing and realizing the potential for inquiry-based science to support the development of English language for elementary students (Lee, Quinn, & Valdés, 2013; Quinn, Lee, & Valdés, 2012). Teacher professional learning is a key element to both understanding and realizing this potential. Since 2008, the Institution,[1] in partnership with a school district, has investigated the development of professional learning experiences for elementary teachers that focus on the relationship between science and language learning. The project is based on the premise that inquiry-based approaches to science require greater communication and more sophisticated uses of academic language, thereby engaging students in linguistic work that can support their English language acquisition (Lee, Maerten-Rivera, Penfield, LeRoy, & Secada, 2008; Lee et al., 2013; Stoddart, Pinal, Latzke, & Canaday, 2002).

This qualitative case study looks closely at the professional development (PD) experiences of an elementary teacher who participated in this program since its inception. She developed a hybrid practice of using inquiry-based science to teach both science content and English language development (ELD) to her students, many of who are English language learners (ELLs). This case study examines the teacher's reflections on her teaching and her students' learning as she engaged her students in science learning and supported their developing language skills. It explicates the professional learning experiences that supported the development of these pedagogical practices (Rankin et al., 2015).

Over several years, she participated in professional learning experiences that were developed to provide her with the opportunity to view the language practices of her ELLs from an asset perspective. These experiences included summer workshops that were designed to immerse teachers in their own science learning and push their ideas about language learning in the context of science. Study groups were held periodically during the school year and provided opportunities for

[1] The name of the institution and school district has been changed for the blind review process.

teachers to develop and share expertise[2] with curricular units, problem-solve classroom concerns and consider new ideas. These experiences were designed to help teachers develop instructional practices over time that created affordances for all of their students to engage with science phenomenon in a manner that supported both their developing science understanding and their English language proficiency. Georgia's teaching reflects the most definitive growth in her ideas about learning science and language as well as shifts in her classroom practice that are resonant with these new views of language. Her growth provided the opportunity to closely examine the pedagogical practice and reflections of a teacher who is developing an inquiry-based approach to both science learning and language development and provide insights into how teachers come to integrate their professional development experiences with their classroom expertise in order to create a hybrid inquiry-based science ELD practice.

This qualitative case study contributes to the emerging scholarship on the development of teacher practice of inquiry-based science instruction as a vehicle for both science instruction and ELD for ELLs. This study demonstrates how an effective teaching practice that supports both the science and language learning of students can develop from ongoing professional learning experiences that are grounded in current perspectives about language development and that immerse teachers in an inquiry-based approach to learning and instruction. Additionally, this case study also underscores the important role that professional learning opportunities can play in supporting teachers in developing a deeper understanding of the affordances that inquiry-based science can provide for language development.

Theoretical and Practical Grounding

This study is based on the view that inquiry-based science is an effective way for all students to learn science. Inquiry-based science is a pedagogical approach to engaging students in making sense of science ideas. It is based on engaging students in investigations of real-world phenomena using science practices. It involves students in observing phenomena, asking questions that are meaningful to them about the phenomena, looking for answers to their questions and sharing ideas that are developed through their investigations. Teachers take on roles such as facilitator, support person and guide during science learning that is rooted in inquiry much more than giver or assessor of the answers (Institute for Inquiry, 2006).

This work is further grounded in research that demonstrates that inquiry-based science is an effective way for students to come to understand science ideas and practices (National Research Council, 2012). While there have been debates in recent years about the term "inquiry-based science," there has been consistent agreement that the most productive conception of inquiry is the view that it is an approach that is formed of specific science practices (Milano, 2013; National Research Council, 2013). These practices have recently been defined in the context

[2] For the purposes of this paper, expertise and expert are conceptualized as complex and context dependent and not necessarily equated with subject-specific knowledge (Eaude, 2014).

of the Next Generation Science Standards (NGSS) (National Research Council, 2013). For instance, the Science and Engineering practices strand of NGSS has been explained as "inquiry unpacked" (Milano, 2013).

Given this view of inquiry-based science, this study is based on research that sees inquiry-based science as a supportive and fruitful learning context for language development (Rankin et al., 2015). Research has shown powerful connections between language acquisition and science, suggesting that a focus on the combination has the potential to reinforce both (Fradd & Lee, 1999; Lee & Fradd, 1998; Pearson, Moje, & Greenleaf, 2010; Rosebery, Warren, & Conant, 1992; Stoddart et al., 2002). The integration of ELD and science learning holds great promise for advancing student achievement of ELLs as well as native English speakers (Lee, Deaktor, Hart, Cuevas, & Enders, 2005; Lee et al., 2008; Thomas & Collier, 2002). With the adoption and implementation of the NGSS, the language demands embedded in the science and engineering practices make clear that explicitly attending to the language and discourse in science classrooms is essential in order for students to successfully engage with these science practices (Quinn et al., 2012).

Given the challenges created by the language demands inherent in the new standards, teachers need to develop current views of language acquisition in order to shape instruction that will effectively engage ELLs in science practices. As the number of ELLs grows in schools, the needs of this population of students can pose a considerable challenge for teachers (García, Beatriz Arias, Harris Murri, & Serna, 2010). These challenges are compounded as many teachers working with ELLs often do not feel sufficiently prepared to work with this group of students (Darling-Hammond, Chung, & Frelow, 2002; Gándara et al., 2005). These challenges are exhibited in schools in a number of ways. One is the opportunity gap facing ELLs and their teachers in schools (e.g., Goldenberg, 2008; Olsen, 2010). This lack of opportunity often manifests itself in the prescriptivist notions of language that are prevalent in schools, curriculum, assessment and policy (e.g., Sayer, 2008; Snow, 1987). These prescriptivist notions of language view language development as a linear process of learning that privileges language structure over the development of communicative skills. This has a tremendous impact on instructional practices and the way in which developing language proficiency is measured. For example, accuracy is often the focus of instructional practice and assessment rather than communicating understanding. This view of language has resulted in a "curricularizing" of language instruction (Valdés, McSwan, & Alvarez, 2009). Language development is seen as a series of grammatical lessons that build on each other rather than a series of experiences that afford ELLs the opportunity to engage with rich content and practice communicating their developing understanding of that content.

This paper draws from socially oriented theories of second language acquisition (Block, 2003) as well as sociocultural theories of language development (Cook, 2002; Frawley & Lantolf, 1985; Lantolf, 2000, 2006) that concern themselves with understanding how second language learners become users (i.e., speakers, writers, readers) of a second language. These theories recognize that school and classroom contexts impact language growth, development and opportunity. Building on this perspective of language acquisition, this paper views language pedagogies and

practices in congruent ways focusing on the belief that ELLs are capable of engaging in high level content instruction with support (Lee et al., 2013; Walqui & Van Lier, 2010) that engages them in meaningful and purposeful tasks that provide authentic opportunities to use and communicate with language (Wong Fillmore, 1992). A key aspect of our conceptual frame is that teachers need to see language acquisition as emergent from use of language and facilitated by scaffolds that enable ELLs to engage in the language demands of particular contexts. Our premise is that developing this view of language acquisition is necessary for teachers to use inquiry-based science as a good context for ELD.

The professional learning experiences that were a part of the project were designed to help teachers come to understand how inquiry-based science can be a good context for students' language development and for enacting classroom practices that reflect this understanding. The workshops and study group sessions that were the core of the professional learning activities were based on research that finds that the most effective teacher professional learning comes from teachers having immersive experiences in learning science through inquiry (Loucks-Horsely, Stiles, Mundry, Love, & Hewson, 2010; National Research Council, 2000). This literature provides rationale for immersing teachers in their own learning as a way to help them shift their think about children's learning and modifying their practice based on these views. The teachers were also provided curriculum materials as resources for inquiry-based science teaching that supports language development. The design of the curriculum resources resonates with recent notions of educative curricular materials for supporting teachers' growth in content knowledge as well as pedagogical content knowledge (Davis et al., 2014). The teacher in this case study experienced a strategy for professional learning that combined immersion experiences with ongoing work in professional learning communities (Danielson, 2006). This combination of professional development activities has been used to support the growth of teachers in coming to understand learning in content areas and inquiry-based practices (Loucks-Horsely et al., 2010). The power of creating a professional learning community for developing self-reflective practitioners, knowledge generation and professional development has been well documented (Darling-Hammond & McLaughlin, 1995; Roth, 2007).

Reflective practice can be supportive of teacher learning and a lens for how teachers are making sense of their experiences. The professional learning experiences that the teacher in this case experienced were designed to encourage teachers to reflect on their practice so as to improve their instructional approach (Danielson, 2006). This case study is formed by examining a thread of reflective discussions following classroom practice that the teacher had designed for engaging her students in inquiry-based science activities. Each discussion was a part of the teacher's ongoing inquiry into teaching science as a context for both science and language learning in collaboration with the researchers. The teacher's reflections on her students' engagement, her facilitation moves and her goals and practices constitute her sense making about language acquisition, science learning and pedagogy that supports the integration of both. Lines of research related to reflective practice by teachers have established that moments of reflection are sites for understanding how teachers' ideas about content and pedagogy are informed by their interpretations of personal experiences, views of learning and ideas about their students (Brookfield, 1995; Loughran, 2010). Engaging

in reflective practice is an indication that teachers' ideas about learning science and ELD are growing. Through reflection, they can move beyond a knowledge base of discrete practices to integrate and modify skills within specific contexts, moving toward internalizing skills and enabling invention of new strategies (Larrivee, 2000). In this way, reflections help to constitute teachers' inquiry into their own teaching that results in professional learning.

Research Questions

The research question for the overall project was:

- What kinds of professional learning experiences support teachers in developing an understanding and expertise around the role of inquiry-based science in supporting science engagement, science learning and language development?

The specific research questions that generated this case study were:

- What can we understand about a teacher's developing ideas about language acquisition and inquiry-based science pedagogy by examining her reflections on inquiry activities?
- How does this teacher come to see the relationship between inquiry-based science and language development?

Methodology

This case study is part of a larger research and professional development project that is funded by a US Department of Education i3 Educate to Innovate Grant. The project is a collaboration between a small school district with a large population of primarily Spanish-speaking ELLs and a professional learning program within a science museum.

The District is a small, semirural district 1 h north of San Francisco. At the elementary level, the district is comprised of five schools with 90 teachers and approximately 1800 students. Within the elementary student body there is an average per school of 60 % ELLs, 58 % of students receive free lunch, 9 % of the students receive reduced lunch. Four of the five elementary schools have a history of being in Program Improvement status under No Child Left Behind. The persistence of this designation motivated district administration to partner with the Institution to explore new approaches to working with English language learners. Over the course of the project, all 90 K-5 teachers within the district will have received at least 2 years of workshops and study groups led by Institution staff and teacher leaders that amount to a minimum of 30 contact hours per year. Teachers also receive resources for teaching inquiry-based science that can support ELD. These resources include two curriculum units per grade level (a life science and an earth science or physical science), including hands-on materials.

The goal of this project, now in its fifth and final year of major funding, has been to develop an approach to professional learning that will help K-5 teachers to

increase their ability to teach science as a context for English language development. This approach was designed based on best practices in professional development that support teachers in transforming ideas about science learning and translating their new ideas into teaching that is more oriented to inquiry-based science learning. Our designs were based on the premise that teachers may need to also develop views of learning language that could allow them to attend to language acquisition and support for ELD while teaching science. There are two key aspects of the science-focused parts of this design. One is to immerse teachers in inquiry-based science experiences as learners, mirroring the experiences teachers will ultimately provide for their students (Institute for Inquiry, 2006). This aspect was primarily addressed through summer workshops. This approach also includes engaging teachers in extensive reflection on their own learning and the pedagogy that supports inquiry-based science that nurtures language acquisition. Reflection and discussion were the focus of study groups held periodically during the school year for all teachers. And for a small group of teachers, including the focal teacher for this study, additional reflections occurred following classroom observations.

Focal Teacher

The study focuses on Georgia who taught 2nd/3rd grade in an elementary school within the district that was consistently low-performing on standardized tests. Additionally, her school had a high population of English language learners. This school was the pilot school that had been involved in all three phases of the project. Georgia is one of the eleven teachers who have been a part of the project since its beginning. During the 2013–2014 school year, Georgia had 23 students, 80 % of whom were ELLs. This was Georgia's ninth year of teaching. Georgia has been highly involved during each phase of the project, including the pilot project and the current federally funded project, as a teacher and as a teacher leader who additionally collaborated with the museum team. She is an active teacher leader who attributes her participation in the science and ELD initiative as supporting her growth in both classroom teaching and teacher leadership.

At the beginning of the work with the pilot school, Georgia was one of the teachers who was most engaged in thinking about and trying inquiry-based science. She actively participated during every year of the project in all the forms of professional learning that were provided: workshops, study groups and teaching using the inquiry-based science kits. Her participation and leadership increased over the phases of the project. At the beginning of the project, she worked diligently and creatively to incorporate ELD strategies into work with science. During study groups, she shared expertise gleaned from examples of her teaching. She also shared ideas from working with her colleagues about what they were noticing about students' learning of science and language. Over the years of the project, she grew from seeing science as a good way to encourage students' talk to recognizing how to design ways for the meaning making that is involved in inquiry-based science to become a context for using and therefore developing English language. This paper is an examination of her growth in thinking about science as a context for ELD

through a series of her reflections and classroom practices during the fourth year of the i3-funded project.

Data Sources

Data for this case study includes fifteen 1-h classroom videos taken between November 2013 and May 2014. Data were collected from her teaching of three inquiry-based science units. "Shadows" was taught in the fall of 2013, "Snails" was taught during the winter months of 2014, and "Magnets" was taught in the spring 2014. Videos focused on Georgia's teaching and student talk during inquiry-based science instruction of units designed for the science and ELD initiative. Following each of the classroom videos, Georgia reflected on her practice with members of the research team (i.e., the authors of this case study). These reflections were also recorded. Select classroom videos and reflections were transcribed for closer analysis. Additionally, descriptive reflective memos were written by members of the research team following all of the professional learning experiences starting in 2012. All of the data quoted in this paper is taken from transcriptions of Georgia's reflective discussions with team members.

Analyses

Data analysis involved systematically watching and re-watching the videos, reading and re-reading the transcriptions of the selected videos and reflections, and reading and re-reading the memos to identify themes and patterns that addressed the research questions (Erickson, 1986). Using principles of grounded theory (Glaser & Strauss, 1967), data analysis was initially inductive, and then applied concepts from the literature on the knowledge base of the relationship between science and language learning (e.g., Lee et al., 2013) and the role of professional learning experiences in impacting teacher practice (Garet, Porter, Desimone, Birman, & Yoon, 2001). We systematically read through all of the data multiple times to identify codes and relationships among them (Erickson, 1986).

We identified three major themes in the data. First, Georgia's thinking shifted over time about ways to engage her students of different English language proficiency levels with science. Second, she was able to create a "space" (e.g., Science Talks) in her classroom for her students to talk about their developing ideas and understanding. Finally, she discovered that the opportunities for her students to make sense of real-world phenomenon provided important affordances for her ELLs to develop the language to communicate their ideas.

Findings

When the project began, despite not having previously teaching science from an inquiry-based perspective, Georgia "bought-in" early on in her professional learning experiences to the merits of this type of instruction. She recognized the opportunities for her students for deep science learning and genuine engagement, and she experienced this as a learner as well. She was both an eager participant in

her own inquiry-based science experiences and enthusiastic participant to share her developing understanding with her students. Over the course of the project, Georgia opened up her classroom to the authors and welcomed the opportunity to have her practice observed as well as reflected upon afterward. It is through her own reflection in collaborative conversations that she was able to articulate the beliefs underlying her practice as well as the ways in which her practice and thinking had changed as she participated in the professional development. As mentioned above, a number of important themes emerged from our analysis of Georgia's practice and her reflections. Within each of these themes, a number of sub-themes emerged that explicate her thinking, the choices embedded in her pedagogical decisions, and the ways in which she theorized her developing inquiry-based science and language practice.

Her Shifting Thinking About the Role of Science Learning in Language Development

Georgia's participation in and teaching of inquiry-based science helped to push her thinking about what it meant to engage her students of different English language proficiency levels with science. The hands-on experiences provided her students of all language levels with an authentic, highly engaging experience that cultivated interest in science content and purpose to communicate this interest. No longer was English proficiency a prerequisite for science learning. Rather, it was the inquiry-based science learning experiences that provided learning opportunities for both science and language.

As Georgia became more comfortable and skilled with inquiry-based science instruction, she was able to modify the curriculum she was given to leverage more language work in response to her students' various language needs. Georgia was particularly focused on the role of context in language development, the relationship between writing and talking, and what student talk meant and did not mean during Science Talk.

Let's Give Them Something to Talk About!

Previous to her experiences using inquiry-based science as vehicle for ELD instruction, Georgia's understanding of language development was informed by more traditional and prescriptive views of language acquisition. In reflecting on her practice she confirmed that ELD for her was "teach nouns, teach verbs and that was ELD", but that "it wasn't working…my students were still struggling, they didn't use language, didn't talk…and nothing was happening." Georgia talked about the important shift she made and acknowledged that the professional development opportunities and the learning about and experiencing first-hand inquiry-based science had contributed to a different understanding of language development as well as changes to her practice. She shared,

> I've grown so much. When I first started doing ELD and stuff before we had this…I would make them [her students] say it the correct way after me, say,

> "No this is how you say it. Say it after me." I mean, like, are you kidding me? Why did I ever do that? They probably hated me as a teacher.

Georgia had come to see the vital role that experiences with real-world phenomenon play in both science learning and language development.

> I gave them something to talk about. They had the snails and the pictures and they had the evidence and the things and right in front of them and they knew exactly what they wanted to say because it was right there. It was real. It was tangible. They had the words. They knew exactly what to talk about.

The Relationship Between Writing and Talking

In addition to her shifting understanding of language development and the importance of contextualizing talk, Georgia's ideas about the relationship between writing and talk changed over time. Georgia came to see an important connection between talk and writing, particularly for her ELLs. As her ideas about writing and talking developed, she began to make pedagogical choices that intentionally connected writing and talk believing that writing their ideas down would help students talk about their ideas out loud.

> I'm going to have them get their journals so that they could write down things that they notice. But I don't want them to take too much time writing. I want them actually observing…We'll come to a stopping point. We'll write a little and then we'll share…that way then they just –they have something written down maybe to share that they've noticed. And that might help with some participation, also.

In addition to coming to understand that the writing of ideas supports the talking about ideas, Georgia also saw that the talking about ideas could support the writing of ELLs. While she theorized that writing down ideas helped her "quieter" ELLs talk about their ideas to the larger group, she also had ELLs who were quite verbal, but struggled to express themselves through writing. During one of her lessons, she gave her students a series of explicit steps to move from their talk to writing.

> My reasoning for doing that is that—because when they tell me the answer, they know what to say to me. When it comes to writing it down on paper, they can't get it on paper. They don't know what to write. They don't know what to put. They don't know what word goes where. So my new practice is exactly what you just said to me goes on the paper. So say the word, write it down. So if they're speaking and writing it at the same time, then I know the words are getting down on the paper. Because telling me and talking to me about it, they can do that. But when I ask them to put it on paper, it's difficult. So I'm trying to have them talk to me and write those words and talk at the same time, so that at least they're talking to someone, or they're talking to the paper, and the words that are coming out can go on the paper.

These pedagogical choices represented a shift in her thinking about the interconnectedness of the language modalities and the ways in which both speaking and

writing could work in tandem to support ELLs in more clearly communicating their developing science ideas and understanding. Georgia, through her pedagogical choices, was theorizing about the connection between oral and written language. Georgia had two groups of ELLs in her class who were struggling. One group were quiet girls who struggled to share their ideas orally whole class, but were able to express their ideas through their writing. The other was an outspoken group of boys who had no trouble talking about their ideas in the whole group, but were incredibly challenged when asked to write their ideas down. Her experience with inquiry-based science and the enthusiasm and engagement that she observed in her students allowed her to see the strengths of her students and think about how these strengths could be capitalized on to help in the areas in which they were struggling. The result was that she differentiated her instruction for these two groups of students focusing on how the boys' talk could support their writing and how girls' writing could support their whole-class talk.

Not Everyone has to Speak During Science Talk

Science Talk was a central focus of the professional development experiences that Georgia engaged in and much of her energy was spent focused on scaffolding Science Talks for her ELLs. After realizing the important role that Science Talk could play in supporting students' understanding and communication of science ideas, Georgia wanted to ensure that all of her students could participate in the whole-class Science Talk. However, over time her goals around participation in the whole group Science Talk shifted from being an activity where everyone needed to participate to an activity that afforded students an array of opportunities to engage in a diversity of language experiences. Georgia had come to see language learning as more than production of language orally.

> I'd like to see more kids talking than just the dominant, more comfortable speakers but not everyone has to speak every Science Talk, that's not a standard of mine. I'd like them to speak at least once during one Science Talk but as long as they're hearing the repeatedness (sic), the repetitiveness of the language and they're listening to their classmates and hoping that it's getting into their repertoire of thinking so that they can eventually use it or recognize it or use it in their writing and maybe gain a confidence in the future to speak. Not everyone has to speak every Science Talk but I will encourage them in the next one to go ahead and try to speak.

So while participating in the whole group Science Talk was important, it was not necessary for Georgia to recognize that a student was engaged, learning and further developing their language.

Creation of Spaces for Science Talk

Georgia's initial enthusiasm with inquiry-based science was with the science, both the content and the process in which the content was taught, and the opportunity to engage with real-world phenomenon. However, over time Georgia

became increasingly enthusiastic for the ways in which inquiry-based science provides opportunities for language development. Georgia, like many teachers, had often struggled to support her ELLs to communicate their ideas in authentic ways. Georgia found that through the structures that inquiry-based science provides, she was able to create authentic and meaningful "spaces" for her students to talk about their developing ideas and understanding of science. These "spaces," usually in the form of Science Talks, supported both their science learning and their language development. Georgia was particularly focused on her role as a facilitator during Science Talk and the structures she used to support Science Talk for ELLs.

Role of Facilitation

Georgia took her role as a facilitator of the Science Talk that occurred in the class very seriously. This consciousness developed over time through her ongoing professional development experiences as well as her deepening understanding of inquiry-based science. This understanding of science coupled with her knowledge of what worked and what did not work with her students, helped her to define her role as a facilitator in the classroom. Georgia did not see this role as a fixed role and was not always sure "how it's supposed to look", but rather as a role that responded to the needs of her students. Georgia was clear about what she wanted Science Talk to sound like: Science Talk was "a conversation about things where the kids do most of the talking without me." Her facilitation role extended beyond the whole-class Science Talks to her role throughout all of the inquiry-based science experiences her students had. Reflecting on the complexity of her role, Georgia said,

> So I constantly move in this classroom. I don't think I ever sit down and I'm always going from table group to table group during inquiries and observation times because I want to listen to them. I'm now a facilitator…so I'm here to listen and encourage talk…I will go and I'll plant myself with the group. I'll talk a little bit, ask some questions to the get conversation going and then leave it with someone…I am going around asking questions to encourage thought, to really check-in, to see what they're thinking and what they're understanding and then my questions let me evaluate their thinking and understanding of the subjects so I can plan further instruction. So I know where I'm going next, so I understand this group didn't use any vocabulary. This group isn't looking for evidence, they're just watching. This group's moving the snails all over the place so you know, it really give me insight then to their thoughts and action and why they're doing these things.

For Georgia, facilitation of her students' experiences during science extended to all of the activities the students were engaged in, but she was particularly conscious of her role to support and encourage talk in her students both to support their language development and to assess their understanding in order to impact her planning. She saw her role as facilitator as one of question-asker and encourager. This role was thoughtful, intentional and student-centered.

Structures for Science Talk

When Georgia was initially introduced to the idea of Science Talk early on in her professional development, it was introduced as a whole-class strategy. Georgia and her colleagues quickly realized that conducting a Science Talk with large numbers of ELLs was going to be challenging to facilitate in ways that would support all of the students to engage with Science Talk, make meaning of their experiences and the experiences of their peers and participate actively in an experience that was a critical component to their inquiry-based science instruction. Georgia and her colleagues began to modify the traditional whole-class Science Talk structure to best meet the needs of her students. In reflecting on her practice, Georgia noticed that some of her students "clammed up" when in a whole-class Science Talk whereas they were more willing to share with partners and in small groups.

> Well, when I was going from pair to pair to pair, I was getting some pretty amazing observations. And that was powerful because they actually were using the words and showing me and that kind of stuff. But then, when I put them in whole groups, some of the people who were talking to me, like Jaqueline, she was on it. She was talking to me. She was telling me everything. And then when I put her in whole group she clammed up. And she didn't really want to say anything. So I have got to work on that….

These kinds of experiences with students like Jaqueline allowed Georgia to experiment with the structure of Science Talks. Where deepening science learning was the original goal of Science Talks, Georgia came to see Science Talks as an important opportunity to both deepen science understanding and provide opportunities to develop language. Georgia came to understand that some of her ELLs needed this opportunity to be structured differently than a whole-class Science Talk.

Putting Science at the Center

Georgia came to understand that the opportunities for her students to make sense of real-world phenomenon (magnets, shadows, snails) provided important affordances for her ELLs to develop the language to communicate their ideas. It was the phenomenon, not textbooks or cloze sentence starters, that gave her students something to talk about. The "doing" of science became the impetus to communicate. This understanding of where real science learning and language development resided was a critical area of learning for Georgia and came to dominate her pedagogical planning and practices. The science units were designed with a number of explorations throughout. These explorations were the times during the unit where the students were most directly interacting with phenomenon. Georgia found these explorations to be an invaluable affordance for both science learning and language development.

Real-World Phenomenon as an Important Affordance for Language Learning

As Georgia became more comfortable teaching the inquiry-based science units, the role of the experiences with phenomenon became increasingly important in her thinking about science learning and language development. Georgia recognized these experiences with real-world phenomenon as more than just opportunities for language learning, but actual affordances that supported the development of language. Quickly, these experiences with phenomena guided her teaching and led the students' learning. Georgia saw phenomenon as the context by which both the science ideas and language were developed.

> I believe that language can't develop without a context in which to practice it. I can teach nouns. I can teach verbs. But without a hook, something to match it to, they're just words on the page.

Georgia realized that it was the phenomenon that was the affordance, not the Science Talk or writing, but the actual interaction with the real-life objects. This became clear to Georgia as she observed students' engagement with explorations, but she also thought deeply about the role the materials could play in helping students articulate their ideas in Science Talk. When she reflected on the students that struggled to share whole class, she was brought back to the role of the phenomenon and said, "Maybe they should have the materials with them to do the talking." This connection between experience, regalia and talk was an important change to Georgia's practice. She came to see the materials and phenomenon as an affordance rather than as a crutch.

Importance of Multiple Experiences with Phenomenon

Although the explorations in the units were originally designed for the teachers to teach once, Georgia came to see that the explorations were at the heart of the science learning and language development for the children. Given how engaged with and excited by the hands-on explorations, Georgia realized that the more often the students could have multiple experiences with phenomenon, the better. During the spring of this study, Georgia and her class were in the midst of an inquiry-based science unit on snails. The students had loved their experiences with snails and were investigating the food preferences of snails and trying to figure out how to explain these food preferences. Georgia was hoping that the students would "make a connection between what snails eat and what snails drink" through the experiences with phenomenon and begin to see that "a snail doesn't need to drink because there is liquid in the food." After multiple experiences with the snails and observing their food preferences, Georgia observed that "clearly some people made that connection" between food and liquid for the snails, but not everyone was making that connection. Georgia was not concerned. Georgia saw this as an opportunity for the children to have another experience with phenomenon and to support this experience with different questions and focus as well as get clearer about what the students were going to communicate about their developing understanding.

> Because on Monday, we're going to compare the two [food and liquid]. So we're going to compare and talk about what foods the snails ate and what was in them. Were there liquids in those foods that they had gotten? So that maybe that's why they didn't need to drink any liquid.

The students' multiple experiences with phenomenon had allowed them to go deeper into the snail unit than the curriculum was originally designed for. This deeper push into the science grew out of Georgia's realization that multiple experiences with phenomenon supported her students' engagement and interest in science as well as their language development. These repetitive experiences allowed them to refine their ideas about phenomenon as well as practice communicating their ideas about what they were learning.

Keeping Ideas Complex is Better for Science and Language Learning

Through her own experiences doing inquiry-based science and teaching inquiry-based science, Georgia came to see the work of learning and communicating about science as work that was grounded in ideas. Previously to her teaching of inquiry-based science, science had rarely been taught at her school and when it was it had been taught through textbooks. The inquiry-based science opened up a world for both her and her students. Together they were investigating and discovering new ideas. They were all highly motivated by the inquiry-based science. The complexity of ideas excited Georgia. She realized that inquiry-based science provided an important space for students to grapple with ideas and that doing so, not coming to a right answer, was what supported both their science learning and their language development.

During her class's inquiry about shadows, Georgia realized that the complexity of the ideas around shadows was challenging for her students, but this challenge was important. The students were negotiating the relationship between light, a light blocker and a screen that resulted in a shadow. She was not interested in making it easier, but rather in supporting her students with additional experiences with phenomenon to help them clarify their ideas.

> He's [student in the class] got some of it [ideas about shadows]. And a lot of them have some of the pieces as far as, like, what the whole shadow thing is about. But you can tell there's some misconceptions out there about shadows or how they're made, and especially with the sun and light and do other things make shadow and that kind of thing. So it'll be interesting to find out what happens when we get back and we do the indoor shadow lesson with the light.

The students' communication of their ideas was a critical part of learning how to communicate their developing science understandings, even when those understandings were initially misconceptions.

Discussion

This case study is informed by the close analysis of Georgia's practice as it emerged through her own reflection on her practice. It highlights the critical role PD played in the transformation of a teacher's stance toward inquiry-based science instruction and its relationship to language development. Georgia's case illustrates that her experiences in PD, her experiences teaching and doing inquiry-based science and the opportunities to reflect on her practice contributed to her theorizing a hybrid practice of inquiry-based science and ELD. This hybrid practice, the blending of her developing content and teaching knowledge, has often been referred to as pedagogical content knowledge (PCK) (Cochran, 1993; Shulman, 1986). The nature of blending content knowledge about both science and language along the pedagogical knowledge for teaching science and language also reflects Ball, Thames and Phelps (2008) extension of PCK to content knowledge for teaching. The development of this hybrid practice reveals itself to be an incredibly important and necessary space for Georgia to grapple with the complexity of teaching rigorous science content while attending closely to the language needed to communicate this science content. This capacity to theorize her own practice grew out of her PD experiences that encouraged deep reflection on both her experiences in the PD and her experiences teaching (Van Driel & Berry, 2012).

The importance of how we "do" PD is revealed in the case of Georgia. Her experiences in the PD "doing" inquiry-based science were as critical as her experiences learning to teach inquiry-based science. Georgia believes that the PD positioned her as both a learner and an expert and built on her expertise as a teacher and as someone who knew her students and their strengths and challenges deeply. In addition to building on this expertise, it drew on it as well. The PD counted on teachers, like Georgia, to share their knowledge of practice with ELLs, their challenges teaching science and supporting language development and their understanding of how children learn. Although some of the teachers' initial ideas conflicted with the theoretical stance of the PD, it was through uncovering and listening to teachers' understanding of teaching and learning, as well as their understanding of diverse students that teachers like Georgia were able to begin to theorize and develop a hybrid practice that encompassed inquiry-based science and language development.

Georgia was part of the project and the PD from the beginning and in many ways her growth and development as an educator reflect the growth and change of the project. Like Georgia, the project was coming to understand the relationship between inquiry-based science and language development and how to convey this relationship to teachers. The project was deeply grounded in inquiry-based science and committed to understanding more clearly the role of language in science learning, but the project did not "know it all" when it began. In essence, the project and its participants were learning together and it was the opportunity to learn together that afforded everyone involved the opportunity to deeply reflect on their practice. For the teachers, like Georgia, it afforded them the opportunity to deeply reflect on their teaching practice and ongoing learning. For the project staff, it

afforded them the opportunity to reflect on their understanding of science-inquiry and PD and how intentionally focusing on language impacted and challenged this understanding. Everyone involved in the project was working toward theorizing a hybrid practice of inquiry-based science and ELD.

Implications

With the adoption of the NGSS and the Common Core State Standards (CCSS), teachers are confronted with standards that require sophisticated and diverse language use. For teachers working with ELLs teaching these new standards can be a daunting task. Language is involved in all of these standards in distinct and important ways that teachers must attend to. Language is required to communicate and make meaning of the content standards, it is an explicit part of the English language arts standards, and it is addressed in the language-convention-specific standards as well (Kibler, Walqui, & Bunch, 2015; Van Lier & Walqui, 2012). However, these new standards ask teachers to conceive of language differently than what has often occurred when teaching English to ELLs. Language acquisition is no longer viewed as a linear process that occurs in the mind of the individual but rather as a social process that views language development from a usage perspective (Valdés, Menken, & Castro, 2015).

We are in a critical moment where the PD support for elementary school science teachers working with ELLs is of tantamount importance. This case study shows the value of a close analysis of a teacher's reflection on her inquiry-based science instructional practices that attend to both science and language development in pushing our understanding of the role of PD in supporting elementary school science teachers working with ELLs. The language demands inherent in the NGSS and the challenges that they present for ELLs have been well documented and discussed (Lee, Miller, & Januszyk, 2014; Quinn et al., 2012) as well as the need for rigorous PD for elementary school science teachers (Lee & Buxton, 2013). The reflections analyzed in this study suggest that the professional learning activities that Georgia participated in overtime contributed her development of hybrid practices. An implication of this growth is that there is a need for further study of projects that modify existing robust professional development approaches to support teachers in developing the science learning put forth by the NGSS as well as an understanding of science learning as a critical opportunity for language development.

This connection between science and literacy also points to future implications of this case for building greater understanding of literacy development connected to all academic content that is necessary for the implementation of the Common Core State Standards (CCSS) (Van Lier & Walqui, 2012). This line of thinking will bring to light another aspect of professional development that is important to addressing the dual responsibilities of addressing CCSS and NGSS that most schools will be facing in the coming years.

This case study underscores the important role that professional learning opportunities can play in supporting teachers in developing a deeper understanding of the affordances that inquiry-based science can provide for language development.

It also illuminates how predesigned PD learning experiences need to make space for teachers to bring their own expertise and concerns into these learning experiences. It is in these spaces, where both learning and expertise exist, that deep reflection occurs and can transform practice.

Finally, this case study points to the role of teacher expertise in re-framing and re-designing pedagogical practices to better meet the needs of students. Georgia knew who her students were and she knew both their assets and their challenges. Through her professional learning experiences, she developed an understanding of the important role of Science Talk as a pedagogical strategy to support science learning and language development. However, the way in which the strategy was introduced to her (as a whole-class activity) had to be re-framed in order to better instantiate the practice to meet the needs of her students (i.e., in small groups, facilitated groups and pairs). Professional learning experiences cannot be fixed experiences, but rather experiences that illuminate theory and give teachers rich learning experiences themselves so that they may theorize their learning to fit the classrooms and students that they know better than anyone.

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