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PROMOTING SOCIAL NORMS FOR SCIENTIFIC DISCOURSE: PLANNING DECISIONS OF AN URBAN ELEMENTARY TEACHER

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Abstract

This case study examined planning decisions made and challenges faced by an elementary teacher in a high-poverty urban district to promote students' adoption of social norms of interaction for scientific discourse. Through interviews, document analyses, and observations during a science unit, the findings indicated that the teacher's planning first involved creating a classroom climate whereby students felt safe to share their thinking. Next, she provided students with structures for interaction and strategies for discourse based on knowledge she acquired from professional development in evidence-based discourse. She also incorporated these dialogic practices in all subjects to extend student practice. The challenges in promoting scientific discourse included accountability pressure, inadequate resources, limited time, paucity of collegial collaboration, and student variability in discourse.

***Keywords**:* elementary science, teacher planning, urban education, scientific discourse, social norms

The vision underlying the Next Generation Science Standards (NGSS, 2013) is that *all students* acquire knowledge and scientific practices for informed decision-making on national/global issues (NRC, 2012). To achieve this goal, NGSS (2013) recommends that students make sense of science ideas through practices of investigating questions and formulating, evaluating, and communicating evidence-based explanations. Socio-cultural researchers posit that students can construct understanding of scientific concepts through inquiry and reasoning in dialogic interactions with peers (Mercer, Dawes, Wegerif, & Sams, 2003). Yet, teachers in urban schools with high-stakes pressure to improve students' standardized tests scores typically employ teacher-directed approaches of drill and memorization versus student-centered practices of critical thinking and explanation-construction (Darling-Hammond, 2007; Thadani, Cook, Griffis, Wise, & Blakey, 2010). Teachers' use of didactic, highly managed approaches, often found in schools serving low-income minority communities, can result in students' passivity in learning (Calabrese Barton, 2001).

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However, there is growing evidence of elementary teachers in urban schools promoting students' collaborative inquiry learning (Carlone, Haun-Frank, & Webb, 2011; Varelas, Pieper, Arsenault, Pappas, & Keblawe-Shamah, 2014). Case study narratives provide insight into how teachers in urban schools have reformed their science instructional practice (Johnson, 2011; Upadhyay, 2005). Yet, observational studies have shown that though teachers may engage students in hands-on investigations and data collection, there is significantly less emphasis placed on evaluating claims or negotiating explanations with peers (Forbes, Biggers, & Zangori, 2013). To compound this problem, young students' conversations for science meaning-making are not always productive (Galton & Williamson, 1992). Mercer et al. (2004) suggested that students may not be aware of criteria for collaborative, effective discussion. With the NGSS intent that all students engage in reasoned dialogue for scientific meaning-making, narratives of teachers' efforts in this area are needed, particularly in urban school contexts.

Preparing students for explanation construction requires *teachers' awareness* of norms for discourse focusing on scientific meaning-making (Herrenkohl & Guerra, 1998; Palinscar, Anderson, & David, 1993). Thus, the purpose of this study was to examine the *planning* of an elementary teacher in a high-poverty school who promoted social norms for students' scientific discourse and the factors that challenged the planning. Planning, a cognitive activity, involves a teacher's thinking, judgments, and decisions in preparing for instruction (Clark & Peterson, 1986). The warrant for examining teacher planning is based on findings that teachers' decisions can profoundly influence students' learning opportunities (Shavelson & Stern, 1981).

Conceptual Framework

The development of NGSS was grounded in research suggesting that young children, regardless of background or socioeconomic level, have greater capacity to reason and engage in scientific discourse than previously assumed (NRC, 2007). Scientific discourse involves extended teacher-student and student-student dialogue of observations, reasoned arguments, and plural explanatory ideas to make sense of investigations (Mercer et al., 2004; Osborne, Erduran, & Simon, 2004). This discourse for science meaning-making is in contrast to closed questioning traditionally used in elementary classrooms to ascertain student's knowledge. Research suggests that teachers can foster students' scientific discourse by providing explicit guidance in how to express and evaluate ideas as well as revise claims (Driver, Newton, & Osborne, 2000;Herrenkohl, Palinscar, DeWater, & Kawasaki, 1999).

In urban classrooms, factors can impact enactment of scientific discourse including the students' perceived role, students' exposure to scientific content/language, and teacher knowledge of discourse norms (Brown, 2006; O'Neill, 2010; Osborne, et al., 2004). Students are unlikely to participate actively in science discussions without perceiving teacher-student-student relationships as safe for sharing (Matsumura, Slater, & Crosson, 2008; O'Neill, 2010), especially if student voice is viewed as disruptive (Diamond, Randolph, & Spillane, 2004). In addition, students from different cultures come to school with varying levels of ease in appropriating discursive science practices (Brown, 2006). Brown reported that ethnic minority students in high-poverty schools experienced a cultural disconnect with the language of science that they viewed as "only applicable to the classroom culture" (p. 121). To address African American and Latina girls' disaffiliation with science, Carlone, Haun-Frank, and Webb (2011) identified teachers' normative scientific practices of equitable participation structures, ways of thinking scientifically, and approaches to idea exchange that allowed students to view themselves as "science people" and position them as collaborative producers and users of scientific knowledge (p. 480).

The conceptual framework used for this study was Palincsar, Anderson, and David's (1993) social norms for science discourse as participatory behaviors appropriate for collaborative discussion. The norm, *contribute to the group's efforts and help others contribute*, involves students' sharing resources, discussing ideas, and assuming job responsibilities. Next, *support one's ideas by giving reasons*, constitutes students' giving evidence and examples of their ideas. The norm, *work to understand others' ideas*, suggests students give peers time to think, ask clarifying questions, and restate others' ideas to confirm understanding. Finally, *build on one another's ideas*, involves students comparing ideas, acknowledging others' ideas, and explaining reasons for disagreement.

The field of teacher planning has identified factors contributing to teachers' pedagogical judgments including teachers' beliefs, subject matter conceptions, instructional activities, grouping strategies, resources, and perceptions of students' intellectual, participatory, and behavioral capacities (Shavelson & Stern, 1981). Inquiry into teacher planning for science instruction can illuminate a teacher's awareness and promotion of social norms for scientific discourse.

Methods

Case study methodology was used to examine one urban teacher's planning for scientific discourse (Merriam, 1998). Case study design, employed for in-depth understanding of meaning made by individuals in a given context, is particularly suitable for examining decision-making in education (Yin, 1989). Two questions guided this case study: How did an elementary teacher in a high-poverty school plan to promote social norms for students' scientific discourse? What factors challenged the teacher's planning for scientific discourse?

Participant and Context

Ann (pseudonym), a fourth grade White middle-class teacher, was selected purposefully from a larger study examining urban teachers' beliefs, knowledge, and resources in planning for reform-based science. The teachers were chosen from eight urban elementary teachers identified by nomination/observation for implementing reform-based science (Patton, 2002). The researcher had no prior relationship with the teachers, schools, or districts. The decision to focus a case study on Ann's planning for social norms of scientific discourse was based on observations that her students gave reasons for explanations and collaborated in evaluating each others' ideas from science investigations. In contrast, students in the other classrooms reported findings without evaluation of claims.

Ann taught for 14 years in a Northeast urban district where 40.9% of the children lived in poverty. Her class of 23 students, 100% receiving free/reduced lunch, included 19 from the Dominican Republic, Puerto Rico, or Colombia; two White; one African American; and one Cape Verdean. Six students received learning support and two students were English language learners.

Ann's district was on probation as "low performing" for not meeting state assessment goals in reading and math. Though state science test results were not considered for district proficiency, Ann's district adopted an inquiry-based science curriculum and provided science kits, consultant support, and professional development (PD). Five years earlier, Ann taught science from a textbook and lacked confidence in science content. To advance her science pedagogy, she participated in inquiry science workshops and Accountable Talk® PD, an evidence-based discourse approach (Michaels, O'Connor, Hall, & Resnick, 2010). She also sought mentoring in Responsive Classroom® practices for students' pro-social interactions (Charney, 1991).

Data Collection and Analysis

The data sources included a one-hour initial interview; seven 45-minute interviews during her ten-week magnetism/electricity unit; two planning meetings with her White, middle-class colleague, Marie (pseudonym); planning documents including the science kit teacher guide, teacher plan book, and student worksheets; and interviews before and after two observed science lessons.

Data collection and analysis were an on-going process to follow leads and seek clarification of developing patterns (Merriam, 1998). Initially, data were coded based on Palincsar, Anderson, and David's (1993) social norms for scientific discourse to identify how Ann planned for their implementation. From a repeated review of the data using an open coding system, insights emerged about factors that promoted and challenged Ann's planning for scientific discourse (Erickson, 1986; Patton, 2002). To increase trustworthiness of the findings, two researchers unrelated to the project gave perspectives on emerging patterns during weekly discussions and Ann ascertained accuracy of interpretations from member-checking (Merriam, 1998).

Findings and Discussion

To depict Ann's experience planning for students' incorporation of social norms in scientific discourse, results were reported using a narrative of Ann's planning for an electricity/magnetism unit (Connelly & Clandinin, 1988). Five themes emerged reflecting Ann's planning decisions and the challenges she faced: classroom climate of caring and respect, structure for social interaction, discourse strategies in the science classroom, time for discourse, and expectation of collaborative discourse.

Classroom Climate of Caring and Respect

Ann laid the groundwork for discourse during the first month. She noticed students "asking questions in their heads that they don't ask each other. I don't think they feel comfortable enough to say it to their classmates." Thus, from experience with Responsive Classroom®, Ann's initial plans involved establishing a safe classroom climate and sense of community (CRS, 2015).

> "Beginning the year, we talk what it would be like in a group that's working cooperatively, what it would sound like, how we expect things to run in our classroom. We talk about family and how we would treat our family members. It's through modeling and conversations and buying into the classroom rules and respect. I don't tell them class rules. They create them."

Ann also planned for promoting student caring:

> "I read this book, *Chrysanthemum*, about a girl mouse. When other mice make fun of her name, she gets a little tear in herself. We have this paper that we tear. So they understand, once something bad is said, even if we apologize, the person is never the same. So, they always bring up, 'We shouldn't do this because they're never going to be the same.'"

During lessons, Ann prompted students, "We are here to help each other"--evidence of this planning focus.

One challenge in planning for a respectful classroom was the class composition each year. Ann explained,

> "Last year, I had two strong personalities that led the group astray. This year, I have two children who struggle. If the two students are off, the other kids work hard to keep them going. They connect to each other."

Ann's experience with Responsive Classroom® informed her planning for a collaborative, respectful climate as an essential first step before students could adopt social norms of *contributing to group efforts* or *helping others contribute* (Palincsar, Anderson, & David, 1993). Since many students were recent immigrants, Ann wanted them to feel safe in sharing ideas publicly. Her planning aligned with findings indicating that students engage more in discourse with explicit classroom expectations for pro-social interactions (Matsumura et al., 2008).

Structure for Social Interaction

After establishing a foundation of trust, Ann planned structures for students' collaboration during investigations. She assigned students purposefully to "heterogeneous groups so they can carry each other" and each group could be "cohesive and a strong group together." For example, she placed "struggling readers in strong science groups." Yet, Ann also reassigned students if needs were not being met, particularly for English language learners.

> "I have four kids in a group and one had all the knowledge about magnets. He's a limited English speaker. He's had a lot of exposure and great knowledge, but he's having a hard time following the language and completing inquiry tasks. It could be he doesn't feel confident because he's an English language learner. I don't know if the girls are bullying him. I need to realign that group."

Ann's plans included replacing one student with "a quiet laid-back strong academic child. She knows a lot, but she's not pushy about it. He feels more confident asking questions. So it's a good fit for everyone."

For constructivist learning in science, Ann recognized students needed to adopt the norm of listening to other's ideas; thus, she planned for students to practice active listening.

> "Students have to be sitting in a way to listen to each other, not just listen to be respectful, but they have to listen so they are taking it in so they can either add on to what they are saying or disagree or agree with it."

Yet, one student did not allow others to contribute: "The group is getting frustrated with her. She has a hard time slowing herself down and she wants to be the one doing all the inquiry." Ann regrouped the student with peers who expected equal participation. In addition, she assigned student numbers "so people who get materials are not the first person who jumps out of their seat. I'm making decisions so the group works more cohesively."

Ann's planning was consistent with Osborne, Enduran, and Simon's (2004) recommendation that a collaborative social context and explicit participation structures are needed to foster student discourse for scientific meaning-making. By grouping to maximize collaboration and providing practice in listening, Ann prepared students for the norm of *working to understand others' ideas* (Palincsar, Anderson, & David, 1993). Also, through participation structures and neutralizing dominating speakers, Ann created a more equitable environment for student expression (Mercer et al., 2004).

Discourse Strategies in the Science Classroom

Students conducted science investigations such as determining how to design single or multiple pathway circuits as well as how to create an electromagnet to pick up metal pieces. Ann's view of students' background knowledge influenced her planning for science discourse during these investigations: "It's a poor Spanish speaking community. Many parents cannot read the materials we send in English….the kids don't have exposure to this type of [science] vocabulary, so we have to focus on it." Ann was cognizant that families faced financial struggles and; consequently, believed that parents had limited opportunities or resources to expose their children to science terminology used in school. Thus, Ann's planning involved introducing vocabulary for use in their discussions: "In the beginning of the unit, you need to frontload a lot of knowledge. As they gain knowledge themselves, you can do less." While Ann was reshaping her science teaching to include discourse for student's collaborative meaning construction, she still made some decisions based on her perceptions of student deficits.

Limited human and material resources also challenged Ann's planning. Since the district had "difficulty recruiting teachers" for Accountable Talk® PD, Ann did not have a collaborator in planning for scientific discourse. She only planned with her colleague, Marie, "about what we're going to teach," not "how we're going to teach it." Though the science kit teacher's guide suggested how students could design science investigations and report results, there were no tips for student comparison and evaluation of findings (FOSS, 2005).

Yet, from Accountable Talk® PD, Ann learned "talk moves" such as explaining reasoning, restating another's reasoning, and critiquing someone's reasoning (Michaels et al., 2010). Since her students struggled with "making claims and getting evidence," Ann modeled and established routines for providing evidence-based claims and discussing others' ideas. For example, each student would draw his/her idea of a particular circuit, "set up the circuit in the group, and walk through it." Next, group members used discourse norms "to ask questions and talk it through." She explained, "My goal is they figure out why it does or doesn't work and work off that." She planned questions such as "How do you think that happens?" "What do you think about his idea?" to prompt students to deepen their thinking, evaluate claims, and build upon others' ideas.

Ann's understanding of norms--*support ideas with reasons and evidence* and *understand, evaluate, or build upon others' ideas* (Palincsar, Anderson, & David, 1993)—grew from Accountable Talk® PD. Her knowledge of active listening and "talk moves" informed her to adjust science kit directions for more scientific discourse. Given that elementary teachers typically rely on science teachers' guides (Mulholland & Wallace, 2005), this finding suggests a need not only for teachers' guides to scaffold for scientific discourse, but also for teachers to broaden their planning to include norms for students' collaborative construction of scientific understanding.

Time for Discourse

Though the district limited science lessons to 30 minutes, Ann made time for discourse. After investigations, Ann gave students "lag time to have real conversations and provide evidence and not rush through it." She wanted students to practice collaborative science talk,

> "My goal every week or every lesson is to have discussion in Accountable Talk®. I want to give them time to use the strategies in their small groups. They need to feel confident and say, 'I think we should go this way and this is why.'"

Likewise, Ann planned for students to give each other time. When a boy from Cape Verde hesitated to express his ideas in English, she prompted students, "You need to listen to him. He has something you really want to know." She understood that "he just needed time to express himself" so his ideas were not overlooked.

Since Ann's district made insufficient progress on state assessments, teachers focused instruction on reading and mathematics, thus limiting science class time and student opportunities for scientific discourse--a common obstacle to science reform in urban districts (Goldston, 2005). Ann met this challenge by integrating Accountable Talk® in other subjects.

> "I focused my whole math lesson on Accountable Talk® and I could see them jumping off of each other. I'm hoping that with more of it, they're going to be able to do it without me saying, 'What do you think? Why do you think that?'"

Ann understood students needed practice in evidence-based discourse and planned for cooperative group "talk moves" in all subjects so students could converse more effectively during the available science time.

Expectation of Collaborative Discourse

An essential element in Ann's planning was her *expectation* that students engage in scientific discourse. Her plans included prompting students routinely, "What you claim, you need evidence," "Why do you think that?" Students' circuitry conversations provided evidence of their meaning-making discourse, "Listen to him. He said all the ways it didn't work and we only gave the ways it did work. I think his is better because he gave all the reasons it didn't work too." Ann *expected* students to evaluate each other's claims, "build off each other's ideas," and consider follow-up investigations to generate more accurate explanations.

However, some students with learning or language needs struggled with this expectation. Ann explained, "My big thing right now is that some kids are struggling [with discourse]. They're not causing a ruckus, but they're not getting what's going on either." She addressed this issue through "peer modeling" and encouraging groups to give each other time to express ideas. For example, an English language learner "gets confused with what he's saying" and one group member "slows down the discussion to give him time to express himself."

Urban education literature indicates that students' academic performance is linked to teachers' expectations (Duncan-Andrade, 2007; Ladson-Billings, 1994). In research with low-income minority students, Diamond, Randolph, and Spillane (2004) reported that teacher's expectations of and sense of responsibility for student outcomes impacted instructional decisions. Ann's story shows how one teacher set expectations and planned for students to acquire science discourse practices.

Implications and Conclusion

Developers of NGSS (2013) contend that equity in learning opportunities should be given priority in educational decision-making, particularly for students marginalized from limited economic, social, and educational resources. To prepare all students for informed citizenship, NGSS highlights the need for access to quality science education that includes participation in dialogic practices when constructing understanding in science. In support of extant research, this study's findings showed how an urban teacher planned to build students' capacity in reasoning and constructing evidence-based explanations in science by explicitly teaching discursive practices (Driver, Newton, & Osborne, 2000; Osborne, Enduran, & Simon, 2004).

The results provide insight into one teacher's planning in a high-poverty urban school to develop students' normative practices for scientific discourse. Though these findings are not generalizable to the wider urban education community, they may illuminate how a teacher planned for students' dialogic sense-making of science despite pressure to focus on high-stakes subjects. Implications from this study for teachers, teacher educators, administrators, science kit developers, and PD providers include the need to consider the content and scaffolding for social norms and scientific discourse available from material and human resources to support teachers. Since Ann could not depend on curriculum materials or her teaching partner to grow her understanding of scientific discourse, she sought out resources for norms and discourse strategies. The study also suggests the need for research in approaches that support students who struggle with discourse. Given the NGSS vision that all students receive equitable opportunities to learn scientific practices for informed decision-making, it is vital to highlight efforts of teachers in urban schools who plan for building students' capacity in evaluative, evidence-based discourse—skills needed for an educated citizenry.

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