Title of Project:  
Scientific Inquiry as Social and Linguistic Practice:  
Language Socialization Pathways in a 9th Grade Physics Class

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Summary of Research Findings

Introduction  
Students designated as English Learners (ELs) by the U.S. public school system consistently score lower on standardized tests than their native-English speaking peers (National Center for Education Statistics, 2013). In some cases these performance gaps persist after students exit English as a Second Language (ESL) programs (Short, 2002). ELs are identified for special education services at higher rates than their native English-speaking peers (Sullivan, 2011), and ELs are more likely to live in poverty and to drop out of high school than their mainstream peers (U.S. Census Bureau, 2011). In addition, ELs and other language minority students who come from an array of racial and ethnic minority groups are underrepresented in STEM (science, technology, engineering and mathematics) fields.

Improving education for language learners in STEM requires teacher educators in content areas, such as the sciences, to view the language of science as an object of study and as an object that requires explicit classroom instruction. Popular approaches to integrating language and content instruction (e.g., Echevarria, Vogt & Short, 2013) provide content area teachers with some of the instructional skills needed to simultaneously promote students’ development of language and content knowledge. However, case study research reveals that students need more than skills and knowledge in order to appropriate “smart science student” identities (e.g., Carlone, Haun-Frank & Webb, 2011; Brown, 2004, 2006). In order to meet the societal goal of promoting language learners’ access to mainstream careers in the sciences, we must explore not
only how ELs learn language and content, but also how EL students construct disciplinary identities as they participate in scientific investigations in science classroom communities.

**Methodology**

The research described in this report draws from a physics classroom ethnography that employs a language socialization framework and a social semiotic approach to across event discourse analysis (Wortham & Reyes, 2015) to understanding how three bilingual Latina students are socialized into or out of student science expert identities through peer interactions during scientific inquiry tasks (i.e., tasks that pose questions or problems rather than present a set of facts).

**Research questions.** I ask the following research questions about the classroom community and the socialization pathways of the three focal participants:

1. (a) What local identity models are associated with success during inquiry instruction in one 9th grade physics class? (b) How do students discursively construct these identities?
2. (a) What pathways of socialization do three bilingual Latina students undergo while participating in science inquiry labs? (b) How do these pathways relate to students’ language and science content learning?

I answered these questions by collecting ethnographic (e.g., field notes, artifacts, etc.) and discourse data (video and audio recordings) in one 9th grade physics classroom during the 2014-2015 Academic Year. From the over 200 hours of recordings I collected, I selected three individual lab tasks to serve as the focal events in my corpus. Altogether my corpus contained almost nineteen hours of peer interaction.

**Participants.** The school, Science For All Academy (SFAA; all names for places and persons are pseudonyms) was a district run science-focused charter school. The focal participants in this study are three bilingual Latina students who were all 14 years of age at the beginning of the study. Rose was born in the U.S. but did not identify herself as an American; in addition, she regularly spent time with family in Mexico. Gu Jun Pyo was born in Peru and immigrated to the U.S. when she was approximately eight years old. OneDirectioner emigrated from the Dominican Republic two years prior to the start of this study and she was classified as an English Learner as a result of testing at the school. There were no other Latina students in the diverse classroom in which this research was conducted although there were three Latino students as well. Most students in the classroom were native English speakers. The teacher was in his 13th year of teaching at the time of the study and he held state teaching endorsements in multiple physical science domains (e.g., physics, earth science, etc.) and in teaching English as a Second Language.

**Findings**

In answering my first research question I found that students in this classroom constructed three different identity models associated with academic success: the good assistant, the good student, and the science expert. I refer to each of these positions as identity models for “success” because occupying one of these roles lead to explicit and implicit positive feedback from students’ peers and the teacher. The identity positions were marked linguistically by how and when students used: scientific vocabulary, stance-taking behaviors, peer nominations,
evaluations of peer performances, permission, and silence. Students also varied in how they used or controlled materials and with whom they consulted when they were uncertain in how to proceed with their tasks (e.g., the teacher, other science experts, etc.). The identity positions were somewhat flexible in that an individual could occupy two identities in one interaction (e.g., the science expert and the good student) or a student could occupy different identities in different lab groups. This finding is significant because it challenges the idea that there is one presentation of the “good science student” identity in a classroom. Classroom discourse studies that focus only on teacher-lead classroom discourse in whole class discussions fail to account for the ways that peer interaction can inform disciplinary identity development. This is particularly important to consider in classrooms where students often work in groups and in classrooms where only a few students dominate whole class discussions. For some students, their only verbal contributions to classroom discourse come during peer interactions. This dissertation demonstrates how students position themselves and how others position them with respect to disciplinary identities in one science classroom. In addition, my analysis of how students developed and articulated positions of expertise demonstrates that “science discourse” during lab tasks may include little science vocabulary even when scientific concepts are being implicitly negotiated. As a result, the language of expertise in science classrooms is not composed only (or even primarily) of the lexical items of the scientific discipline, but of the pragmatic strategies necessary for negotiating social status.

In answering my second research question I found that there were limitations on the flexibility of the identities that the three focal participants constructed over the course of the inquiry tasks in my corpus. For example, Rose was positioned as a good assistant by her peers and via her own actions in the first two labs. In the third lab she attempted to be recognized as a science expert but she was denied a position of expertise due to her lack of knowledge on how to use the lab computer. Tracing and comparing the socialization pathways of the three girls revealed four generalizations that have important implications for teacher education.

First, disciplinary identities are co-constructed among peers during lab tasks. When considering students’ agency as language learners, we must consider how peer language socialization constrains this agency. Second, students from families with higher socioeconomic status and scientist parents more readily achieved science expert status in their peer groups. This dissertation demonstrates how children reproduce the social hierarchies present outside of the classroom when they work in groups without teacher intervention. Third, Mock Spanish (Hill, 1999, 2008) appeared to serve as an important resource for socializing Spanish-speaking students into roles of marginal participation in their peer groups. Fourth, the teacher’s instructional choices directly and indirectly influenced peer interaction in profound ways even when he spent little time with individual groups. Three teacher practices directly influenced peer socialization: lack of instruction on how to operate as a collaborative group, lack of adequate instruction on how to use lab equipment, and requiring students to learn what they missed after school absences by talking with peers. In many ways the teacher of this physics class was exemplary, however, these three practices negatively impacted the language and content learning opportunities of the Latina students in this classroom community.
Implications for Teacher Education

In my dissertation I discuss the implications of these findings for research on classroom discourse, language socialization, Latino/as in STEM, and teacher education. I share here my suggestions for how to apply my findings to language teacher education, and in particular to the preparation of mainstream (K-12) teachers for working with language learners in their content areas. First, I advocate for teachers to be trained in classroom discourse analysis. By learning how to analyze classroom interaction in their own classrooms, teachers will gain the reflective and analytical skills that are necessary to address the various socialization phenomena occurring in their classrooms.

Second, if students are required to use specialized equipment in order to complete a task as a group, teachers must ensure that all students know how to use this equipment. By relying on students to teach one another how to use equipment without accountability for doing so, the teacher in this study inadvertently reinforced social hierarchies that were present outside of the classroom. Students who knew how to use equipment did not teach other students how to use it; rather, they used this knowledge to control the group tasks.

Third, teachers should consider how to create rotating positions of leadership in their classrooms and how to support students in developing the expertise they need to become leaders through the use of explicit instruction. Teacher educators and researchers need to conduct more research in this area to test the effectiveness of different approaches for teaching students group leadership and group participation skills. Instruction that prepares teachers to identify the language demands of content-area tasks should include attention to peer group interactions.

Lastly, in my dissertation, I advocate for the creation of a multilingual science fair in the school in which I conducted this study as a means to elevate the status of Spanish and by extension the Spanish-speakers in the school community. The school in which I conducted this research is uniquely situated with a mission to serve diverse students, passionate teachers who share this mission, a science-focused curriculum, an annual internal science fair already in place, and access to resources at local universities. For these reasons, a multilingual science fair would be plausible in this context, but it is not a one size fits all recommendation. My research demonstrates that native and non-native English speaking students’ language ideologies related to speaking Spanish and English were interwoven with students’ abilities to articulate science expertise in one 9th grade physics classroom. Similar phenomena are likely at work in other schools and classrooms where the statuses of students’ L1 languages and cultures are not being promoted by students and teachers. Teacher educators must consider how they prepare teachers of linguistically and culturally diverse students to promote rather than denigrate the status of students’ home languages. How teachers elevate the status of students’ home languages will vary based on their students and teaching contexts, but teachers must be taught to recognize that failure to do so could inadvertently impact students’ disciplinary identity development. Taken together, the suggestions outlined here begin to address the identity-related needs of English Learners in science classroom communities.
References


