Identity Work of Elementary English Language Learners in a Mainstream Science Classroom

by

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ABSTRACT

This study explored the science learning experiences of elementary English Language Learners (ELLs) in a fourth-grade mainstream science classroom in an urban setting. Informed by ethnographic research and case study design, this study interrogated the celebrated and marginalized practices within common classroom procedures and what science-related identities the focal ELLs developed within classroom interactions through the lens of identity as position. Additionally, this study examined how the focal ELLs perceived themselves as science learners and how they affiliated with what scientists do and school science. Data collection lasted for two months and included video recordings of science instruction and classroom interactions, interviews with the focal ELLs, and students' artifacts. Findings revealed that "doing science" in this fourth-grade science classroom was narrowly defined, as the celebrated practices involved mainly following the classroom behavioral codes and telling the right answer to the teacher's questions.

Findings also showed that the three focal ELLs complied with the celebrated practices to various degrees and were positioned marginally or negatively by the teacher and peers. The marginal and negative positioning affected the focal ELLs' opportunities to engage meaningfully in classroom learning activities. Finally, findings regarding the focal ELLs' perceptions of themselves as science learners showed the various ways in which they used their experiences inside and outside the classroom to construct their understanding of and relations with scientists and the science subject. This study provided implications for student science identity research and practice for supporting ELLs in the mainstream science classroom.

DEDICATION

To my family

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CHAPTER 1

INTRODUCTION

Background

The student population in the United States has become increasingly culturally and linguistically diverse. In the state of Arizona where the study took place, English language learners (ELLs)—students who are identified as non-English proficient or limited English proficient by The Arizona English Language Learner Assessment (AZELLA)—represented 7% of the school-aged population in the 2013-2014 academic year, and 79% of them were in primary grades and 83% spoke a language different than English at home (Arizona Department of Education, 2014). Though the percentage of ELLs in the state is not large, the education issues regarding this student population subjected to English-only policies cannot be neglected. Prior to 2000, school districts in the state had the discretion to choose from a variety of program models, including different forms of bilingual education, to develop students' English proficiency and support their academic attainment (Jiménez-Silva, Gómez, & Cisneros, 2014). While many English learners in the state at that time were not taught in bilingual programs, dual language programs were available to serve both English learners and fluent English speakers (Kelly, 2018). However, the passage of Proposition 203 put an end to the local flexibility that existed within school districts regarding the choice of program model for English learners (Mahoney, MacSwan, Haladyna, & García, 2010).

Though Proposition 203 did not entirely remove bilingual programs from public schools, it made Structured English Immersion (SEI) programs the default choice for families, and SEI became the default label for some teachers who had English language learners in their classrooms but could not support them in their first language (Wright & Choi, 2006). Furthermore, a purposeful effort has been taken to greatly limit the number of bilingual programs approved under waiver (Jiménez-Silva & Grijalva, 2012). While bilingual education continued to be available for families who completed a waiver process, the complex and lengthy process led to the effective eradication of bilingual education as few families navigated the waiver process (Wright, 2014).

After the passage of Proposition 203, a large school district in Arizona witnessed a decline from 50% to 15% of their students being served through bilingual education programs in 2011 (Jiménez-Silva, Gómez, & Cisneros, 2014). The number of teachers who have an English as a second language or bilingual education endorsement has steadily decreased (Arias & Harris-Murri, 2009), as with the quality of teacher preparation in the state (de Jong, Arias, & Sanchez, 2010). de Jong et al. (2010) claim that most teacher preparation in the state currently focuses solely on increasing teacher knowledge of state policies regarding SEI, which compounded the issue of offering quality education to ELLs. In fact, the idea of bilingual education was not embraced at the administration level. The Arizona Department of Education established an ELL Task Force that selected a version of SEI with a one-year, four-hour English Language Development (ELD) block to emphasize English language instruction instead of academic content. Leckie et al. (2013) revealed in their critical discourse analysis of the state government's English Learner Task Force meetings that the Task Force set out to develop an educational policy that prioritized the speed of English language acquisition. In the school year 2020-2021, the four-hour ELD block has been revised to two hours and 50-50 dual language immersion is now an approved SEI program model.

Researchers have also investigated the effectiveness of English-only policies. Garcia and his colleagues (2010) argued that due to its highly restrictive language instruction policies, over the post-Proposition 203 period 2005-2009 and during the first year of implementation of the four-hour ELD block, Arizona made little to no progress in closing the achievement gap in reading and math between ELLs and non-ELL students. Compared to two other educational entities, Utah and Washington DC, Arizona continued to fall behind both in percent of ELLs achieving competency in reading and math. The four-hour ELD block did not meet the language and academic needs of ELLs; ELLs in mainstream classrooms and in other instructional arrangement had better academic performance than students in the four-hour ELD block (Rios-Aguilar, Gonzalez Canche, & Sabetghadam, 2012).

Identity and Science Learning

The concept of identity has made its presence into research on literacy (Moje, Luke, Davies, & Street, 2009), second language learning (e.g., Hawkins, 2005; Toohey, 2000), and science learning (e.g., Tan & Calabrese Barton, 2007; Brown, 2004; Kozoll & Osborne, 2004), offering an alternative sociocultural lens for learning other than cognitive perspectives. Gee (2001) defines identity as “being recognized as a certain ‘kind of person’ in a given context” and views the development and expression of identity as accomplished through the medium of discourse. Interpreting Gee’s (2001) view of identity, Moje and Lewis (2007) maintain that one takes on new identities while developing new forms of knowledge and participation. “Deep, participatory learning involves learning not only the stuff of a discipline – science content, for example – but also how to think and act something like a scientist, even if one does not enter the profession of science" (Moje & Lewis, 2007, p. 19).

In the field of science education, Brown and colleagues (Brown, 2004; Brown, Reveles, & Kelly, 2005) devised the concept of discursive identity to interpret the individual and collective co-construction of scientific knowledge and its impact on student identity. Discursive identity, as they put it, "reflects an understanding that speakers select genres of discourse with the knowledge (tacit or implicit) that others will use to interpret their discourse as a signal of their cultural membership" (Brown et al., 2005, p. 783). As students position themselves through discourse, they can allow or deny themselves access to specific knowledge and conceptual understanding in the science classroom. For example, a student's ongoing use of scientific discourse can help establish himself as a knowledgeable peer and signal his willingness to take on such an identity, and the affirmative responses that he receives from the teacher and his peers expand the collective knowledge of the classroom.

While the concept of discursive identity focuses on individual and collective agency within the classroom (Brown et al., 2005), scholars doing identity-based research in science education also use the construct of identity to highlight how issues of power relations and positioning, in both local contexts and more macro contexts, affect opportunities and outcomes of learning science (e.g., Brickhouse & Potter, 2001; Calabrese Barton et al., 2008, 2013; Carlone, 2004; Carlone et al., 2011; Warren & Rosebery, 2011). Within a local science classroom, students are not only positioned as novices but also the "loud and dramatic girl", "group leader" or "reporter" which may afford them relative power and status in the science classroom and potentially change their identity formation and learning experiences (Calabrese Barton et al., 2008). When taking into account the macro context of science and schooling, Carlone (2004) found that upper middle-class girls value maintaining a good student identity more than connecting to real-world, meaningful science and scientists.

Statement of Problem

As language minority students often experience unequal participation in learning than their English-speaking peers in English-dominant classrooms (Christian & Bloome, 2004; Iddings, 2005), it is essential to answer questions about whether ELLs could develop a successful academic identity and how the learning environment in a mainstream classroom affects their participation and academic identity development. My study was situated in a mainstream fourth-grade science classroom in Arizona to explore ELLs' identity work and engagement in science literacy, which poses challenges for all students due to the complexity of scientific language and conceptual knowledge in this subject area.

An increasing number of studies in science education have paid attention to the relationship between identity formation and science learning of marginalized groups such as girls and African American students. However, as most of these studies were conducted in middle school and high school settings, exploration of elementary language minority students' identity development and science learning demands more attention. Additionally, much of the research on elementary ELLs' identity work in academic settings have not been conducted in specific content areas such as science (see Hawkins, 2005; Toohey, 1998, 2000; Willet, 1995). As the subject of science offers contexts for both concept knowledge development as well as language and literacy development of

ELLs (Lee, Quinn, & Valdés, 2013), applying the concept of identity will help researchers understand how ELLs' access to learning opportunities in the science classroom is shaped by their shifting identities over time and across contexts.

Purpose of the Study

From a sociocultural perspective, my study used the lens of identity formation to investigate the participation of ELLs in science learning. Using ethnographic methods and case study design, I intended to study how three case study ELLs identified with and in science.

The following questions guided my study:

RQ 1: What are the common classroom procedures present in this fourth-grade science classroom and what are the celebrated and marginalized practices within these procedures?

RQ 2: What science-related identities do focal ELLs develop through classroom interactions?

RQ 3: How do the focal ELLs perceive themselves as science learners?

Significance of the Study

The significant difference in performance on standardized assessments between ELLs and non-ELL students has been documented by much research. Shifting focus from ELLs' test scores to their classroom experiences in content areas such as science, my study allowed ELLs to use their own voice to tell stories about what science means to them, how they relate to the subject, and what emotions, interests, struggles, and success they attach to science. Considering ELLs' participation in various activities in the science classroom and their access to various forms of language, practices, and interactions, my study brought science teachers and educators implications for designing inclusive instruction that facilitates ELLs' language and literacy acquisition process.

Procedures

I collected data in a fourth-grade science classroom in an urban setting. I visited the classroom during science session three to four times a week over a period of two months. The forms of data I collected include interviews with focal ELL students, video recordings of science instruction, and documents.

Organization

My dissertation will be divided into five chapters. This chapter presents the background and the purpose of my study on ELLs' science identity development. Chapter 2 details the theoretical framework – i.e., sociocultural views of learning, practice theory, a poststructural view of identity – that undergird my research. It also reviews literature in two major areas – ELLs in science education and students' science identity research – and describes how the literature informs my research and what knowledge gap in the literature my study intends to address. Chapter 3 focuses on my study's methods. In Chapter 3, I present information about the research site and participants. I describe my ethnographic and case study design and the different forms of data collected, how the data were collected, and my data analysis methods. In Chapter 4, I report findings for my three research questions. In Chapter 5, I summarize the study's findings, discuss its implications for research and practice, and make suggestions for future research.

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Introduction

This chapter serves two purposes: 1) to introduce the theoretical framework that will undergird my study and 2) to review literature on ELLs in science education and identity-based literature in the science education field. Sociocultural views of learning, practice theory, and a poststructural view of identity form the theoretical backgrounds of my study. Research on the learning and teaching of ELLs in science education has pointed out the resources ELLs use for science learning and challenges faced by ELLs with regard to English language proficiency and the discontinuity between discursive and literacy practices of their homes and those of the science classroom. While research on students' science identity has offered a theoretical foundation for studying identity in my own project, I argue for the need to examine ELLs' patterns of positioning across language and literacy events in the science classroom.

Theoretical Framework

Sociocultural Views of Learning

Conventional views of learning treat learning as a process by which a learner internalizes knowledge, which is discovered, transmitted from others, or experienced in interaction with others. Lave and Wenger (1991) criticize the conceptualization of learning as internalization because it overlooks the nature of the learner, of the world, and of their relations. Vygotsky's (1978) concept of the zone of proximal development has been interpreted differently by scholars. One common interpretation is that the zone of proximal development is the distance between a learner's problem-solving abilities when working alone and that learner's problem-solving abilities when assisted by more experienced people. However, Lave and Wenger (1991) argue that the social character of learning in such interpretation "consists in a small 'aura' of socialness that provides input for the process of internalization viewed as individualistic acquisition of the cultural given" (p. 48).

To extend the study of learning beyond the context of pedagogical structuring, Lave and Wenger's (1991) concept of *situated learning* presents learning as social transformation and takes into account the structure of the social world and the changing relations between newcomers and old-timers in the context of a changing shared practice. A *community of practice,* as they understand, represents relations between groups of people involved in local, historically constructed practices. Learning entails not only becoming able to get involved in new activities, to perform new tasks, or to master new understandings, but establishing a relation to social communities in which activities, tasks, and understandings have meaning and constitute a part. Their concept of *legitimate peripheral participation* provides a way to describe the engagement of all participants with different degrees of familiarity with the specific practices of the community.

Identities, as Lave and Wenger (1991) conceive, are "long-term, living relations between persons and their place and participation in communities of practice" (p. 53). The social structure of the community of practice, its power relations, as well as its conditions for legitimacy determine the possibilities for learning, including what kinds of identities participants can forge in activities. As communities may provide more or less desirable or powerful positions for participants within them, what participants might learn through practices is shaped by the kinds of positions they occupy (Toohey, 2000). This sociocultural view of learning enables me to see each science classroom as a community of practice and that learning science involves not only content but also learning how to participate in science-related communities. What one can do and what kind of identity one can assume in a setting is related to what he/she can access and activate as well as how he/she understands content and rules for participation.

For ELLs, access to academic language influences their participation in the science classroom and influence what kinds of identities they can assume within such a community of practice. Current research has revealed various challenges associated with ELLs' appropriation of academic language or scientific discourse. First, as engagement in English and academic tasks with various participation patterns puts forward differential linguistic demands and requires different ways of using language, ELLs often fail to claim expertise in these activities (Hawkins, 2005). Second, the structure of discursive practices within a classroom may sometimes put ELLs in a subordinate position in relation to the teacher and thus prevents their extensive use and appropriation of academic language to make meanings (Toohey, 2000). Third, peer interaction could either facilitate or constrain ELLs' access to linguistic resources such as ELLs' home language and academic language, as they make an effort to gain legitimate membership within a particular community of practice using English as the dominant language (e.g., Gamez & Parker, 2018; Malsbary, 2014; Norton & Toohey, 2001). Fourth, as ELLs engage in multiple communities of practice (e.g., home, ethnic community, the science classroom), cultural and linguistic discontinuities between the science classroom and their home or communities lead to difficulty of appropriating scientific discourse (Rosebery et al., 1992). Following Bakhtin's (1981) and Gee's (1989) opinion that language is not a neutral medium, Rosebery et al. (1992) point out that discourses are always in conflict with one another due to their underlying assumptions and values, ways of making sense, etc.

Practice Theory

Practice theory concerns the generation of meaning systems as people participate in everyday, local activities and the ways these meaning systems associate people with broader patterns of social reproduction or change (Eisenhart & Finkel, 1998). Practice theory in educational research is grounded in concepts of cultural production (e.g., Eisenhart & Finkel, 1998; Holland & Eisenhart, 1990; Levinson, Foley, & Dorothy, 1996) and situated learning (Lave & Wenger, 1991). Eisenhart and Finkel (1998) define cultural productions as “meanings developed by groups in their everyday activities” (p. 44). When applied to science education settings, cultural production allows us to examine how participants produce local meanings of “science”, “scientist”, “good science student”, and “being scientific” within pervasive meanings (Carlone, 2003, 2004; Carlone & Johnson, 2012; Carlone, Scott, & Lowder, 2014).

Willis’ (1977) watershed educational ethnography, *Learning to labour: How working class boys get working class jobs*, focuses on cultural production and moves beyond cultural reproduction theory which treats students as passive and pliable. He shows that the British working-class lads of “Hammertown Comprehensive” viewed the school’s rewards for class mobility as a false promise, choosing to resist the school and maintain a sense of dignity and solidarity in working-class life. The lads, as active participants who shaped culture in the school, sealed their working-class fate and constructed their own subjectivities through the cultural forms they produced. “Social agents," as Willis (1981) argues, "are not passive bearers of ideology, but active appropriators who reproduce existing structures only through struggle, contestation and a partial penetration of those structures." While the structural inequality of class was indeed reproduced via the lads' resistance, it is also important that the school didn't unilaterally socialize the lads to their working-class position (Levinson & Holland, 1996).

Building on Willis' works and cultural anthropology studies, Levinson & Holland (1996) propose that cultural production also provides a direction for interpreting how human agency operates under powerful structural constraints. It tries to address the question of "how historical persons are formed in practice, within and against larger societal forces and structures which instantiate themselves in schools and other institutions" (Levinson & Holland, 1996, p.14). Thus, cultural production illuminates the dialectic between structure and agency in sites such as schools, where subjectivities are formed through production and consumption of cultural forms (Levinson & Holland, 1996, p.14). Within this framework, individual can challenge prevailing cultural norms, but they have to do this under the pressure to comply with the culture as currently practiced (Buxton, 2001). In other words, individuals are not free to choose any view of the world, any way of acting in class, any definition of success, or any identity for themselves (Eisenhart, 2001).

A concept closely related to cultural production is Holland, Lachicotte, Skinner, and Caine's (1998) *figured world.* Holland et al. (1998) state:

> [A figured world] is a landscape of objectified (materially and perceptibly expressed) meanings, joint activities, and structures of privilege and influence - all partly contingent upon and partly independent of other figured worlds, the

> interconnections among figured worlds, and larger societal and trans-societal forces. Figured worlds in their conceptual dimensions supply the contexts of meaning for actions, cultural productions, performances, disputes, for the understandings that people come to make of themselves, and for the capabilities that people develop to direct their own behavior in these worlds. (p. 60)

Thus, figured worlds represent the rules, guidelines, or social forces that influence the ways people speak and behave (Hatt, 2007). Furthermore, figured worlds can be conceptualized on different scales: they can be as small as different classroom activities (e.g., whole group lecture, small group activities, in Tan & Calabrese Barton, 2007) or be more macro-level and historically enduring (e.g., the figured world of traditional schooling, in Carlone, Scott, & Lowder, 2013).

Lave and Wenger's (1991) theory of situated learning provides another version of practice theory (Eisenhart & Finkel, 1998). While studies of culture productions attend to meanings produced in practice, situated learning alerted us to the content and organization of the activities that people participate in over time (Eisenhart & Finkel, 1998). Lave and Wenger (1991) maintain that knowing and self-identification develop in social situations through the learner's increased participation in a community of practice and that structure and power relations within the community may support or inhibit access to legitimate participation for individuals and thus affect the formation of new identities. Thus, in order to understand how one comes to know and view themselves, it is crucial to first understand how group activities are organized, how knowledge and identity are represented in activity, and how individuals can change their participation over time (Eisenhart & Finkel, 1998; Lave & Wenger, 1991).

In sum, practice theory will allow me to address the following issues: (1) what meanings are produced within and about everyday activities in a particular elementary science classroom; (2) what knowledge, identities (e.g., the meaning of being a scientist, a good science student, etc.), and learning are made socially available in the activities in which the teacher and students participate; (3) how everyday activities and meanings organize participants in wider relations of power.

A Poststructuralist View of Identity

The concept of identity has been defined and studied from various perspectives in different fields. Scholars in psychology and sociology mostly adopt an essentialist perspective that identities are determined by biological, geographical, or cultural factors such as language. For example, social psychologists studying group identities deem that individuals develop beliefs, values, and schemas related to country of origin, skin color, cultural, norms, etc. through personal and vicarious encounters and self-reflection on groupness. For them, the process of negotiation, that is, making decisions about how much one fits with a given group, affords individuals a sense of self (Moje et al., 2009; Roeser, Peck, & Nassir, 2006). In addition, scholars who adopt social psychological approaches to language learning assume a one-to-one correlation between language and ethnic identity (Giles & Byrne, 1982; Noels et al., 1996). However, these essentialist perspectives on identity have been criticized for reducing people to country of origin, phenotype, and other qualities of difference and ignoring individuals' unique life experiences while emphasizing the homogeneity of identity (Bucholtz & Hall, 2004; Moje et al., 2009).

Contrary to the fixed and essentialist view on identity, poststructuralists view identity as fluid, multiple, fragmented, and contested. Weedon (1997), a feminist poststructuralist, uses *subjectivity* to refer to identity and defines it as “the conscious and unconscious thoughts and emotions of the individual, her sense of herself and her ways of understanding her relation to the world” (p. 32). She emphasizes the central role of language in her analysis of the relationship between the individual and the social, arguing that language and subjectivity are mutually constitutive: “Language is the place where actual and possible forms of social organization and their likely social and political consequences are defined and contested. Yet it is also the place where our sense of selves, our subjectivity, is constructed” (Weedon, 1997, p. 21). Furthermore, Weedon (1997) also points out that subjectivities are the results of continuously discursive practices from multiple power relationships (e.g., social, political, economic). Thus, through discursive practices, power structures and controls relations between different individuals. Taking into consideration the power dynamics in discourses, we can see that individuals are not free to choose any identity they want. Social structures (e.g., peer groups, classrooms, schools, governments) within which individuals exist contain the amount and scope of choice available to individuals (Block, 2007).

Like Weedon, Davies and Harré’s (1990) positioning theory also views identity as the product of discursive practices:

> An individual emerges through the processes of social interaction, not as a relatively fixed end product but as one is constituted and reconstituted through the various discursive practices in which they participate. Accordingly, who one is always an open question with a shifting answer depending upon the positions

made available within one's own and others' discursive practices and within those practices, the stories through which we make sense of our own and others' lives. (p. 46)

Speech acts, storylines, and positions make up the three core components in positioning theory. Seeing a conversation as the joint action of all the participants, Davies and Harré (1990) argue that a speech act, which is the social meaning of what has been said, does not refer to the social intention of a person but is determined by how the utterance is taken up by all the participants. Which speech acts a sentence accomplishes depend in part on which storyline speakers take to be in use. It is the storylines that provide possible positions that can be taken up by any speaker-hearer.

Literature Review

English Language Learners in Science Education

ELLs' Science Learning. Studies on ELLs' science learning cover the topics of 1) cultural beliefs and practices related to science learning, 2) resources drawn upon by ELLs to engage in science practices, and 3) linguistic influences on science learning. Studies on cultural beliefs and practice often highlight the inconsistency between culturally specific communication and interaction patterns among nonmainstream students and the expectations of school science (e.g., Aikenhead, 2001; Brown, 2004; Lee, 2004; Lee & Fradd, 1996; Rakow & Bermudez, 1993; Riggs, 2005). For example, Lee & Fradd's (1996) study on oral, written, and pictorial communication of ethnolinguistically diverse students reveal not only the differences among Hispanic and Haitian students, but also their common needs for literacy development. Students often have difficulties interpreting pictorial representations of science tasks and communicating ideas about science in written forms. As for the possible sources of learning difficulties, Lee and Fradd inferred that these difficulties might have resulted from students' limited experiences or prior knowledge related to science, a lack of understanding of the conventions of literacy, and lack of formal schooling in home countries. Focusing on interaction and communication patterns, Brown (2004) found that marginalized students, including African American students and ELLs, expressed difficulty and resistance about using the discursive practices of science. He suggests that students' attempt to reformulate their discursive identities (i.e., social identities based on individuals' selection of genres of discourses) to appropriate the science language should be understood as a move to become bilingual.

Scholars have also explored the resources that ELLs draw upon to engage in science practices such as inquiry, reasoning, and argumentation. These resources include the everyday sense-making practices of students from diverse communities (Rosebery et al., 1992; Rosebery et al., 2010; Warren et al., 2001) and ELLs' home languages and discourse styles (Hudicourt-Barnes, 2003). Before coming to school, ELLs already possess a variety of knowledge, values, and world views acquired from their families and communities that could be leveraged to support science learning (Lee & Fradd, 1998), and some of these home experiences may even be directly connected to school science standards (Buxton & Lee, 2014; Buxton, Salinas, Mahotiere, Lee, & Secada, 2013). Rosebery et al. (2010) and Warren et al. (2001) both propose that heterogeneity of human cultural practices (or heteroglossia in Bakhtin's word), which refers to the varied ways of conceptualizing, representing, evaluating, and engaging the world, as fundamental to linguistic minority students' science learning. Ultimately, learning is viewed as an activity in which heterogeneous meaning-making practices come into contact. However, the intellectual and cultural resources of ELLs are often undervalued by teachers who often tend to highlight their conceptual and linguistic limitations (Buxton et al., 2013; Moje, Collazo, Carillo, & Marx, 2001).

Finally, linguistic influences have been another aspect focused on in research on ELLs' science learning. Students' limited language proficiency limits their science achievement when science instruction and assessment are given predominantly or exclusively in English (Lee, 2005), and the language interference between English and the language of science can impede ELLs' understanding of science (Suriel, 2014). Research that considers linguistic factors in ELLs' science learning study how ELLs use extant linguistic skills in English to learn concepts (e.g., Duran, Dugan, & Weffer, 1998), the impact of English language proficiency and scientific reasoning skills (e.g., Torres & Zeidler, 2002), the role of first or vernacular language (e.g., Brown, 2004, 2006; Stevenson, 2013; Tobin & McRobbie, 1996), and translanguaging practices (e.g., Poza, 2018). Studies on bilingual students' engagement in science show either empowering examples where use of their home language or full bilingual repertoire is allowed to facilitate their participation (e.g., seeking clarification, organizing tasks, sharing knowledge) in science (Stevenson, 2013) and acquisition of the language of science (Poza, 2018) or frustrating examples where a linguistic hegemony based on exclusive use of English sets students up for potential academic failure (Tobin & McRobbie, 1996).

Science Instruction for ELLs. Participation in the science and engineering practices in the science classroom involves both language use and sense-making (Lee, Quinn, & Valdes, 2013). As ELLs face the demands and challenges of content learning through an unmastered language, they need instructional support that promotes both scientific understanding and development of academic language proficiency. Current reviews (Buxton & Lee, 2014; Lee, 2005; Lee & Buxton, 2013) on science instruction for ELLs suggest that to support robust science and language learning, educators should address the following five domains: 1) explicit goals of literacy development for all students; 2) language support strategies with ELLs; 3) discourse strategies with ELLs; 4) building on students' lived experiences at home; 5) home language support.

First, teachers should set up explicit goals for literacy development for all students along with explicit science learning goals. In science learning, literacy involves learning to think and reason, and learning to view and visually represent pictorial and graphic as well as textual communication of ideas and information (Lee & Buxton, 2013). Literacy goals in the science classroom may include comprehension of expository science texts, writing narrative stories based on science-related concepts, writing expository paragraphs describing scientific concepts, using graphic organizers, etc. Merino and Hammond (2001) show how incorporating writing in science inquiry lessons facilitate bilingual students' improvement in both writing skills and scientific understanding.

Second, science instruction should include language support strategies for ELLs. Effective teachers incorporate ESOL strategies (Fathman & Crowther, 2006), facilitate communication of ideas using multiple modes of representation, guide students to comprehend and use key science vocabulary words in context, as well as emphasize hands-on, inquiry-based activities. While hands-on activities offer benefits such as reducing linguistic burden and fostering language acquisition during authentic communication about science knowledge, inquiry-based science promotes ELLs' communication of their understanding in multiple formats and modes and their acquisition of academic language functions (Lee & Fradd, 1998; Rosebery et al., 1992). Also, to engage bilingual students in science inquiry requires the discursive work of teachers, including questioning, reframing ideas, varying use of languages, making reference to classroom experiences, and creating interactional contexts for students to "talk science" (Kelly & Breton, 2001).

Third, science instruction can incorporate discourse strategies that enhance ELLs' understanding of academic content and accommodate to their language proficiency levels. To maintain the rigor of science content and processes, teachers don't have to require exclusive use of science language in the classroom. For example, the teacher in Brown and Spang's (2008) study used a hybrid method of language, which the researchers described as "double talk," involving her explaining science ideas by using vernacular and scientific language. This double talk was also found in students when they produced vernacular and scientific descriptions during explanation. Additionally, effective teachers who recognize ELLs' varying levels of language proficiency allow longer waiting time and provide multiple explanations of the same concepts by using synonyms, paraphrasing key concepts, and recasting and extending students' responses (Gibbons, 2006).

Fourth, effective science instruction builds on students' lived experiences in their families and communities and their intellectual resources. To assist students in constructing new scientific knowledge, teachers need to create spaces in which different discourses and knowledges—from science disciplines, the science classroom, and students' lives—come into contact (Moje, Collazo, Carillo, & Marx, 2001). Lee and Fradd (1998) extend the notion of cultural congruence to include not only the congruence between students' cultural expectations and norms of classroom interaction but also the congruence between students' linguistic and cultural experiences and the specific demands of academic disciplines such as science. To make science instruction culturally congruent, teachers need to ask questions that elicit students' funds of knowledge related to science topics (Gonzalez, Moll, & Amanti, 2005) and use cultural artifacts and community resources in culturally and academically meaningful ways (Rodriguez & Berryman, 2002).

Finally, providing home language support to enhance science learning has been emphasized in research. Home language support include various strategies such as introducing key science vocabulary in both the home language and English, making use of cognates, allowing ELLs to write about scientific ideas in the home language, etc.

Why Study ELLs' Science Identity?

Science for All Americans (American Association for the Advancement of Science, 1990) stresses the value of science literacy. Also, the Next Generation Science Standards (NGSS) prioritize informed decision making and preparation of employment, which makes it necessary for all students, including ELLs, to engage in rigorous science and technology education. However, ELLs' engagement in science learning in the classroom is complicated by issues such as deficiency views of their academic and linguistic abilities and the discontinuity between their home culture and school science. When considering about equitable learning opportunities in science education, Lee (2005) states that science learning outcomes of ELLs should include not only achievement score on standardized tests but also meaningful learning of classroom tasks and affect (attitudes, interest, motivation) in science, as well as becoming bilingual and biliterate with regard to their home language and culture and the language and culture of science. Both meaningful learning and developing positive attitudes and motivation in science closely relate to whether ELLs can formulate a science identity in the classroom.

Regarding the importance of studying identity, Brickhouse, Lowery, and Schultz (2000) propose that to understand learning in science, educators need to know how students are engaging in science and how that is connected to who they think they are. Varelas (2012) links the concept of identity to learning, teaching, and success in science:

> The multiple identities that students and teachers bring with them *and* further construct and reconstruct in classrooms and out-of-school settings allow them to be, and be recognized as particular types of people, act in particular ways, encounter opportunities and barriers, and, thus, experience successes and challenges in learning … Identity construction is intimately related to learning and teaching, educating and being educated. (p. 2)

Thus, from this sociocultural perspective, learning can be viewed as shifts in identity (also see Moje & Lewis, 2007). Furthermore, identity formation makes up a critical dimension of how and why students engage in science by affecting their access to learning and success (Brickhouse et al., 2000; Brickhouse & Potter, 2001). Therefore, identity provides an important lens to study ELLs' participation in science.

Characteristics of Identity in Science Learning

A poststructural view of identity is multiple, fluid, a site of struggle, and subject to power relations in discursive practices. Although studies dealing with identity have various definitions of it, there have been some overlaps among them. This section will review characteristics of identity found in research focused on kindergarten through twelfth grade students learning science. Since agency and structure are essential for discussion on identity from a poststructural perspective, I located identity literature in science learning that deals with both aspects. As I will show in my following review, these studies are categorized into two themes: 1) identity as relational and situated and 2) identity as hybrid. Following these themes, I review the few studies in science education that attend to both agency and structure. This has led to my decision to use practice theory in my study to conceptualize structure and reveal how systems of power shape and are shaped by participants in local contexts.

Identity as Relational and Situated. A poststructural view of identity assumes that we consciously and unconsciously construct our subjectivities or identities in relation to the world (Weedon, 1997). One aspect of identity as relational relates to gaining membership within a community. Lave and Wenger's (1991) communities of practice suggests that learning is a process of coming to be. Through legitimate peripheral participation, learners acquire the norms of participation in a community of practice and what is expected of a community's members, and thus becomes part of the community. The community of practice framework has predominantly guided identity studies in science education (e.g., Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Calabrese Barton, Tan, & Rivet, 2008; Carlone, 2003, 2004; Furman & Calabrese Barton, 2006; Olisky, 2006; Reveles, Cordova, & Kelly, 2004; Reveles & Brown, 2008; Tan & Calabrese Barton, 2007, 2008).

As one of the early works on identity in science education, Brickhouse and Potter (2001) use communities of practice to study the science learning and participation trajectories of two young women in an urban vocational high school. The aim of this study was to understand how the experience of marginalization can make membership in a school science community impossible or undesirable. Both girls, Ruby and Crystal, experienced marginalization and participation in school communities of science and technology practices. Ruby aided her own success and acquired computing competence through interacting with her father and male classmates. Her success had to do with her ability to assume a viable and accepted identity in her male dominated class. In contrast, Crystal, though a good academic student, preferred to get help from her mother who was not well positioned to assist her and limited her interactions with girls who didn't have access to a computing culture like herself. Instead of gaining competence, Crystal remained on the margins and was not able to form a computing identity like Ruby did. Thus, Brickhouse and Potter (2001) raise serious questions for educators about how to help students retain an identity that is desirable in their home communities while still being able to cross the boundaries of race, class, and gender and get access to a computing culture that often resides in more privileged communities.

Brickhouse and Potter (2001) also points to another aspect of identity as relational, which is that gaining membership within a community requires negotiation. That is, the learner needs to adopt an accepted identity in a community in order for legitimate peripheral participation to happen. Lave and Wenger (1991) suggests that the process of coming to be is constrained by the social structure and power relations within a community that may encourage the participation of certain individuals and marginalize the participation of others. However, Shanahan (2009) asserts that the notion of peripheral participation, which tends to take the norms as given and pays more attention to how individuals navigate the norms, attends more to "the process of internalization of norms and accepted meanings rather than to the ways in which these norms are established and the mechanisms through which they control social groups" (p. 57). How individuals negotiate participation and identities have been explored by a number of studies (e.g., Calabrese Barton & Tan, 2010; Olitsky, 2006; Tan & Calabrese Barton, 2007; Varelas, Martin, & Kane, 2012), and only a few of them address the ways privilege and power operate locally in how individuals seek to access resources and position themselves within the community. For example, adopting the concept of figured world (Holland et al., 1998) in practice theory, Calabrese Barton and Tan (2010) examined how youths of 10 to 14 years old, who asserted themselves as community science experts in modeling the relationship between energy use and the health of urban environment, challenged the types of roles and student voice traditionally available in the science classroom. I will further talk about the benefits of practice theory for explaining structure-agency dialectic later.

In a science classroom, adopting the scientific language signals one's membership in the classroom identity. Reveles et al. (2004) state that "in order for students to appropriate the necessary scientific language, they needed to make certain discourse choices that would sustain (over time) their academic identities within this classroom context. By participating as they did, students identified themselves as scientifically literate members of this classroom community" (p. 1136). Scientific language or discourse belongs to the sign and linguistic systems that are essential to the construction of social identities, which Gee (2011) names as capital d "Discourse." Gee (2011) points out that our Discourse is an identity kit to let other people recognize our social identities. Brown and colleagues (Brown, 2004; Brown, Reveles, & Kelly, 2005) devised the term *discursive identity* to examine students' experiences of assimilation in the science classroom and how requirements to use scientific discourse can cause cultural conflict for marginalized students. Discursive identity reflects the idea that speakers select genres of discourse with the knowledge that others will use to interpret their discourse as a signal of their cultural membership (Brown, 2004). Brown (2004) demonstrates four significant domains of discursive identities due to ethnic minority students' differential appropriation of science discourse:

- Opposition Status: students employ strategies to avoid using scientific discourse, including denying knowledge of answers and avoiding discourse opportunities
- Maintenance Status: students attempt to balance the use of science discourse with their native genres of discourse
- Incorporation Status: students demonstrate short-term mastery of science discourse practices
- Proficiency Status: students engage in extensive use of scientific discourse

Brown (2006, 2013) continues the line of inquiry with discursive identity. By interviewing 29 high school students regarding their experience in science, Brown (2006) found that while students experience relative ease in appropriating the epistemic and cultural behavior of science, they also expressed a large degree of difficulty in appropriating the discursive practices of science. He emphasizes school science as a point of potential conflict for students, and science discourse as a potential gatekeeper for students who try to assimilate into the culture of science, which requires them to become ‘bilingual.’ In attempt to bridge students’ ethnic world and academic world, Brown (2013) proposes moving towards identity-based pedagogy and urges science educators to use discursive identities as a resource to improve classroom environments for students who have been traditionally positioned as outsiders in the science community.

Finally, identity is situated in context, is fluid, and shifts from context to context. Gee (2001) used socially situated identities to suggest that people have multiple social identities. A particular social identity is assumed when people recognize the specific social activities that are situated in different figured worlds—“historically contingent, socially enacted, culturally constructed ‘worlds’: recognized fields of frames of social life” (Holland et al., 1998, p. 7). Tan and Calabrese Barton (2007) trace the fluidity of a sixth grader—Melanie’s identity over a year across different figured worlds in her science classroom, including whole class and small groups. Melanie’s identity in the science class is largely dependent on the context. In the whole class, she went from actively engaging in nonparticipation to eagerly seeking participation as a full-fledged member, who was validated by the science teacher. In small groups, Melanie shifted from participating vicariously by shredding wastepaper to displaying commitment and ownership in group projects. Tan and Calabrese Barton (2007) identified factors that enabled Melanie’s transition to a full participant: When she was teamed with friends who supported her, the affirmation and encouragement she received facilitated her slow development of a science identity; as an authority figure, her science teacher allowed and fostered the creation of transient hybrid spaces to help Melanie establish her voice in science.

When thinking about how the above studies address the relationship between structure and agency, one may find that by focusing on individuals as units of analysis, these studies primarily emphasize individuals' agency—how they enact their unique identities and remake who they are by choosing types of discourse and ways of acting. For example, Brown (2004) shows the various stances that African American students take towards scientific discourse and choices made about how to use it: "As we develop an understanding (tacit or implicit) of how discourses enable individuals to become certain kinds of people, individual agency provides us with the power to select discourses to communicate our political, ethnic and cultural identity' (p. 813). Tan and Calabrese Barton (2007) use the term 'authoring an identity' and 'science classroom identity kit' to understand Melanie's identity transformation in various situations.

Among the studies that focus on identity as relational, Gamez and Parker (2018) is one that adds a sociocultural perspective on second language acquisition to their analysis of how interaction dynamics within small groups affect two newcomer students' authoring science-related identities. The researchers pay attention to the role of peers in facilitating or constraining newcomer students' access to linguistic resources that can mediate the kinds of science-related identities they can construct within a reform-based science classroom. For example, the use of language brokering and code switching by Martin's (a case study) peers within their small group allows Martin to author a "good science student" identity in whole-class I-R-E (teacher initiation, student response, and teacher evaluation) discourse pattern.

Identity as Hybrid. Borrowing from the notion of cultural hybridity in postcolonial literary studies, identity researchers in science education have adopted concepts of hybridity and hybridized identity. Cultural hybridity assumes that by bringing together different cultures, colonialism and globalization leads to the emergence of hybrid cultural forms, identities, and experiences. During this process, “the colonized appropriate the language and culture from their colonizers, yet also combine it with their own ways and hence, develop their own hybrid forms” (Rahm, 2008, p. 101). Historically, marginalized students whose experiences lie outside of the dominant culture tend to struggle with school science in its authoritative, technical and often depersonalized form (Lemke, 1990; Roth & Barton, 2004). To theorize this dis-identification with science, Roth (2008) proposes the word diaspora, a notion closely related to hybridity, to refer to the experience of being taken away from what one knows and values and being in another world where we are unfamiliar with the way the world works. Roth suggests that diaspora occurs on a daily basis and does not necessarily involve cross-national migration: “Confronting with differences, individuals continuously engage in cultural bricolage, taking from here and there to make do, producing not only new, heterogeneous, creolized forms of knowledgeability and practice but also producing hybrid identities in a process of continuous métissage” (p. 894). Importantly, the notions of hybridity and diaspora facilitate the theorization of school science as a culture in and for itself which legitimizes a scientifically correct one-and-only way of explaining a phenomenon (Roth, 2008) and helps scholars understand marginalized students’ engagement in science learning or lack thereof (Rahm, 2008).

Lehner’s (2007) case study of Gabriel’s hybridized identity illuminates how he manages to reconcile his multiple lived identities as a self-identified black-Panamanian as well as a youth living in Brooklyn. Although Gabriel struggled with articulating scientific concepts fluently, he heavily drew upon different funds of knowledge and Discourses to make sense of scientific materials. For example, while attempting to describe the ecosystem, Gabriel produced a science creole which integrates his lifeworld language structures and the concepts presented in the class. Using his local speech as a way to connect to the material and the formal language of biology, Gabriel created "a hybrid practice as a gateway to larger understandings" which facilitated his attempts at the macro level enactments of science by multiple participants in the classroom. Based on Gabriel's arduous process of going back and forth between understanding scientific concepts and 'losing' them, Lehner (2007) argues that the hybridization progression or creolized practice should be viewed as a normal strategy students employ in order to gain proficiency in science. Lehner further recommends that students will benefit when teachers officially sanction these unofficial forms of knowledge as authentic science demonstrations.

Recognizing students' hybridized ways of relating to and doing science means opening up new opportunities of learning or "third spaces." Moje and her colleagues (2004) describe third spaces as a hybrid space which brings together and breaks down the oppositional binaries among different knowledges, Discourses, and the relationships one encounters, allowing them to work together to generate new knowledges and Discourses. Moje et al.'s (2004) conceptualization of third space draws from hybridity theory, which "posits that people in any given community draw on multiple resources or funds to make sense of the world" and "examines how being 'in-between' (Bhabha, 1994, p. 1) several different funds of knowledge and Discourse can be both productive and constraining in terms of one's literate, social, and cultural practices - and, ultimately one's identity development" (p. 42). Moje et al. (2004) summarize three different but related views on third space that have been taken up in education research. One view considers third space as a way to build bridges from knowledge and Discourses often marginalized in school settings to the learning of conventional academic knowledge and Discourses (e.g., Gutierrez, Baquedano-Lopez, Alvarez, et al., 1999; Heath, 1983). Establishing such third spaces in the classroom increases academic engagement and learning gains. A second view treats third space as a navigational space, "a way of crossing and succeeding in different discourse communities (Lee, 1993; New London Group, 1996)" (Moje et al., 2004, p. 44). Finally, third space can be defined as a space of cultural, social, and epistemological change in which competing knowledge and Discourses of different spaces interact with each other to challenge and reshape both academic content literacy practices and youths' everyday lives (e.g., Barton, 200l; Hammond, 2001; Moje et al., 2001).

Moje et al. (2004) argue that bringing together knowledge and Discourses in a third space serves as a productive scaffold for young people to learn the literacy practices framed by the Discourses and knowledge privileged in the content areas. As learning in various contexts involves and requires identity shifts (Gee, 2001), Moje et al. (2004) emphasize the importance of examining how drawing from different funds of knowledge connects to youths' identity development. Content area learning, as Moje et al. (2004) argue, is much more than learning the themes or epistemological assumptions of the target Discourse community but a process in which youths' identities become hybrid and framed by an intersection of different funds and Discourses. Calabrese Barton, Tan, and Rivet (2008) took up the concept of third space and explored how middle school girls understand when and how to make use of the multiple resources in support of who they are and want to be and to further their own goals in terms of science engagement. They found that girls create hybrid spaces to strategically create new forms of participation and authority and to position themselves as legitimate participants, rather than being subject to the domination of sanctioned resources and capital in the science classroom. For example, the girls in their study created signature science artifacts which not only communicated who they were and wanted to be, but also attended to and advanced scientific ideas in their classrooms. Furthermore, the girls purposefully and playfully took up novel identities that were distinct from usual science class identities so as to establish epistemic or positional authority while maintaining important social relationships (e.g., they positioned themselves as smart and scientific, yet cool and playful). Drawing from the girls' hybrid science practices, Barton et al. (2008) argues that hybrid spaces, or third spaces, not only validate the girls' out-of-school identities and resources but also rely upon these resources as integral components in science learning. When the merging practices were sanctioned by their teachers and peers, they expanded the kinds of resources that mattered in the science classroom.

From a similar perspective, Rahm (2008) examined how urban youths' positioning and meaning-making processes in science involve hybridity and how hybridity is essential for the survival of youths in a system that positions them as certain types of learners. Among her case studies, the hybridized practices and identities of Tony, Michael, Sabrina, and Tehara were accepted and capable of transforming the activity into a third space which afforded them new possible selves and positions. However, tensions and conflicts that constitute the learning zone of a third space are not always productive, and some can lead to the splitting of discourses and culture. For instance, one of her case studies, Jessica, whose hybrid identity was not recognized as an asset, was repositioned by her teacher as somebody she could not identify with. In conclusion, Rahm suggests that the acceptance of hybridity is key for urban youths to claim insider status and ownership of science.

Hybridity and hybridized identities primarily focus on students' agency and pay attention to how students create new forms of expression, new hybrid spaces, and new possibilities of positional identities in science learning. However, Shanahan (2009) argues that the structural aspects cannot be overlooked as it is structural constraints that necessitate the hybridization. Hybrid spaces and identities, as she proposes, "are not created from scratch; they are created from the structural components of, in this case, the worlds of science and the worlds of the students" (p. 59). Given the role of social structure in necessitating and constraining individuals' agency, I will discuss in the next section the limited number of identity studies in science education that devoted attention to the interplay of social structure and agency.

Attending to Both Structure and Agency. To address the tension of competing foci of structure and agency has been challenging for scholars who study social and cultural processes of learning. While sociocultural theory has been recently critiqued for its lack of attention to macro-level contexts (economic, political, institutional) that shape learning identities while attending to individuals and their local social contexts (Lewis & Moje, 2003; Nasir & Hand, 2006), focusing too much on the macro-level leaves individuals as passive recipients of oppressive structures (Carlone et al., 2008; Moje et al., 2009). To address this dilemma, identity researchers in science education have adopted practice theory as one way to attend to both micro and macro contexts and to examine how individuals exhibit agency within the constraints of social structure (Buxton, 2005; Calabrese Barton & Tan, 2010; Carlone, 2003, 2004; Carlone, Haun-Frank, & Webb, 2011; Carlone & Johnson, 2012; Carlone, Scott, & Lowder, 2014).

Buxton's (2005) study of an urban magnet high school focuses on: the institutional construction of preferred student identity, the ways students in the school took up and transformed this identity, and how gradual institutional cultural shifts took place in response to student practices. The two constructs - 'cultural production' and 'educated person' - from practice theory undergirded Buxton's analysis of the dialectic between structure and agency:

> Culture production is the process by which individuals create meanings in social context through the production of new texts, discourses, and cultural artifacts. These cultural productions can be seen as the vehicles through which human agency operates within larger structural constraints. The second construct of the "educated person" allows practice theorists to critically analyze how the individuals, who are the "products" of education, fit into the historical and cultural conflicts that surround the purposes of schooling. (p. 399)

At the macro level, Buxton discovers that the uses of time, space, and language enacted by teachers and administrators at the high school define an institutional culture that emphasized the goal of helping students gain a framework for high quality academic work that provides the social capital needed for future academic and economic advancement. He explores how individuals and groups (e.g., students who dropped out from the magnet school and who stayed) held different interpretations about constructions of “learning,” “achievement,” “resistance,” and “success” - i.e., the qualities of the educated person - and how the preferred student identity who specializes in math and science was adopted, rejected, and transformed by students. Buxton concludes that the interaction of individual and structural cultural productions resulted in the negotiated construction of specific tasks, social relationships, and networks among various actors (teachers, administrators, students) and that these negotiations put pressure on individuals - both students and teachers - to enact new and different identities.

Like Buxton, Carlone (2004) explores what local meanings about science and scientists were produced in a reformed-based high school physics class designed to promote broadened views of science and how girls internalized the kinds of scientific identities promoted in the classroom. She found that girls either embraced or rejected the promoted scientific identity of scientists as active problem solvers. While those who embraced it already saw themselves as “hands-on” people and “energetic” people who liked doing labs and working with groups, those who rejected it saw it as a threat to their “good student” identities and did not like to be held accountable for the new role. Interestingly, the girls who defined themselves as “lab” people and were successful in the class did not view themselves as “science people” and chose not to pursue further study in physics. Carlone (2004) suggests that this could be partly explained by the fact that most of these girls took this class for credit on their high school transcripts which looked good for college admission. She thus concludes that prototypical (narrow yet pervasive) meanings of science and scientists may have interfered with the potential of transforming girls’ science identities and relationship to science.

Carlone and her colleagues (Carlone & Johnson, 2012; Carlone, Scott, & Lowder, 2014) continued to use practice theory to gain insights into how diverse students' longitudinal identity development was shaped by cultural and structural aspects of science classrooms. Carlone and Johnson (2012) compare three anthropological approaches to science education research: funds of knowledge, third space/hybridity, and practice theory. They argue that practice theory offers a multilevel and multifaceted analysis that switches between contexts and individuals. It allows them to examine their case study - Julio's socio-historical and political positioning, taking into consideration "the socio-historical legacies of school science for Latino males, the cultural practices of his classroom and its implied meanings of 'science' and 'science person', and the ways he takes up, resists, transforms and or negotiates these meanings, positionings and contexts" (p. 168).

Tracing three diverse students' identity work from fourth- to sixth-grade science, Carlone et al. (2014) examined how different science pedagogies and what counts as legitimate scientific performance in fourth- and sixth-grade classrooms enabled and constrained students' identity work as science learners. Holland et al.'s (1998) social practice theory provided the concept of "figured worlds" that guided the authors' research. Here, the authors draw from the cultural production aspect of figured worlds and emphasize that the concept provides the "contexts of meaning for actions, cultural productions, performances, disputes, for the understandings that people come to make of themselves, and for the capabilities that people develop to direct their own behavior in these worlds" (Holland et al., 1998, p. 60). They further made the assumption that macro-level figured worlds, such as the *figure world of traditional school science* and the *figured world of reform-based school science,* influence the types of scientific and social performances and identities celebrated in the classroom. For example, in the fourth-grade science classroom which invoked the figured worlds of reform-based school science and family, promoting socially constructed scientific knowledge, creativity, curiosity, collaboration, and empathy, Michael, a bilingual student, was able to enact identity as a conscientious/worrier, persisting to figure out how to best solve problems with his peers. Also, as the figured world of reform-based science reinforced generative thinking and problem solving as norms, his identity as a good student and pleaser was pushed beyond getting an answer. However, in sharp contrast, when Michael reached the sixth grade, the science classroom became heavily influenced by the figured worlds of traditional schooling and traditional school science and the celebrated identity shifted to the "perfect" performer who gets all the answers correct. Accordingly, Michael's identity work was leveraged to ensure individual accomplishment and getting the right answer. Carlone et al. (2014) highlight the difficulty of prototypical school science in supporting and sustaining nonmainstream students' meaningful science trajectories, because it limits the variety of students' science-related interests and identity work.

Conclusion

The review of literature on science identities in educational settings provides me with ways to theorize identity in my own study. Specifically, the concept of cultural production (e.g., Buxton, 2005; Carlone, 2004) from practice theory in these studies allows me to consider the dialectic between structure and agency. The review of literature on ELLs in science education has informed me of the challenges they face in science learning, what resources they bring to science learning, and the various kinds of instructional support provided by the science teacher.

Science identity studies conducted with students who speak a vernacular language (e.g., Brown, 2004, 2013), bilingual students (e.g., Reveles et al., 2004; Carlone et al., 2014), and ELLs (Tan & Calabrese Barton, 2007, 2008; Gamez & Parker, 2008) have demonstrated minority students' affiliation and disaffiliation with school science and how speaking a nonstandard dialect of English, differing discursive practices between the home community and the science classroom, and limited access to critical linguistic resources result in these students' difficulty to develop affiliation with science, to appropriate scientific discourse, and to become a successful science student. My study set out to extend this body of research by considering how moment-to-moment interactions going on within the science classroom mediated the positioning of ELLs. By studying focal ELLs' patterns of positioning across different learning activities within the science classroom, my study shed light on how ELLs demonstrated affiliation and disaffiliation with school science from moment to moment and whether the celebrated science student identities were accessible for them in particular interactional contexts. Meanwhile, my study also gave voice to ELLs to hear their perspectives on and lived experiences related to science, being a scientist, and being a science student.

CHAPTER 3

METHODS

Epistemology

My epistemological stance is constructivism. In constructivism, individuals develop subjective meanings of their experiences through interaction with others and through historical and cultural norms that operate in their lives (Creswell, 2013). Merriam's (1998) approach to case study embraces constructivism. She contends that "the key philosophical assumption upon which all types of qualitative research are based is the view that reality is constructed by individuals interacting with their social worlds" (Merriam, 1998, p. 6). This philosophical assumption guides my inquiry about the meanings that case study ELLs construct of their experiences with science in the classroom and outside the school and helps me focus attention on interactions among individuals and the contexts surrounding these interactions. Additionally, Merriam (1998) maintains that the researcher brings his/her construction of reality to the research site, which interacts with other people's interpretation of the phenomenon being studied. Thus, constructivist researchers need to recognize how their background may shape their interpretation (I describe my subjectivity as a researcher in a following section). The final product of constructivist research, as Merriam (1998) states, is "another interpretation by the researcher of others' views filtered through his or her own" (p. 22).

Ethnographic Approaches

Ethnography originates from comparative cultural anthropology conducted by early 20th-century anthropologists (e.g., Boas, Malinowski, and Mead) to describe the "ways of living" of a social group (Creswell, 2013; Heath, 1982). These researchers used the firsthand collection of data relating to existing "primitive" cultures, and these field methods differed from traditional scientific approaches to the natural sciences (Atkinson & Hammersley, 1994). As a methodology, ethnography focuses on a culture-sharing group (Creswell, 2013) and studies people's behavior in naturally occurring, ongoing settings (Hymes, 1980). Ethnographers interpret the meaning and shared patterns of behavior, language, and interaction among members of a culture sharing group (Creswell, 2013), how behavior and interaction are socially organized, and the social rules, interactional expectations, and cultural values that underlie people's behaviors (Watson-Gegeo, 1988). Delamont and Atkinson (1995) defined ethnography in educational settings as "research on and in educational institutions based on participant observation and/or permanent recordings of everyday life in naturally occurring settings" (p. 15).

Ethnographies have been used to investigate cultural reproduction of raced, gendered, classed identities and subjectivities in schools (Yon, 2003). This attention to social structures is significant for my study that tries to examine what kinds of science-related identities that ELLs develop within a particular classroom. Carlone (2012) argues that studying individuals' identities in school science can productively take place in concert with a study of culture, as the question of who individual students are becoming in a setting cannot be fully addressed without answering the question of who the students are obligated to be in a setting. In the same vein with Carlone, this dual attention to both structure and agency theoretically informed my study.

An important feature of ethnographic research is the emic-etic comparison (Creswell, 2013; Watson-Gegeo, 1988). Emic refers to culturally based perspectives, interpretations, and categories held by members of the group under study to conceptualize and encode knowledge and to direct their own behavior (Watson-Gegeo, 1988). Emic analysis doesn't simply substitute the terms used in one language or setting for the researcher's own. The researcher's etic extensions that allow for cross-cultural or cross-setting comparisons are based on emic analysis. "The ethnographer first seeks to build a theory of the setting under study, then to extrapolate or generalize from that setting or situation to others studied in a similar way" (Watson-Gegeo, 1988, p. 581). Quoting Michael Agar (1980/1996), Heath and Street (2008) suggest that any ethnographic statement will be "a blend of 'assumptions about perceptions of intent on the part of group members' as well as the ethnographer's background knowledge of related literatures and past research" (p. 44). Both the emic and etic approaches allowed me to unpack the culture of the classroom and the science identities that focal ELLs developed over time: the emic approach offered an insider's viewpoint, while the etic approach allowed me to understand individuals' underlying actions and their co-occurring patterns and contextual features (Heath & Street, 2008).

Case Study Design

Case study is a type of research design and analysis as well as a process and a product of research. It's been recognized as the most widely used approach to qualitative educational research (Gall, Gall, & Borg, 2003). Merriam's (1998) case study design provided guidance for my multiple-case study on reclassified ELLs' science identity development. Merriam (1998) views case as a bounded system, "a thing, single entity, a unit around which there are boundaries" (p. 27). She defines case study as an intensive holistic description and analysis of a bounded phenomenon (e.g., a program, an institution, a person, a process). In my study, the phenomenon of interest was elementary

ELLs' science identity development in a mainstream science classroom, and the cases were individual ELLs.

In terms of epistemological stance, Merriam (1998) believes that constructivism should orient qualitative case study. "The key philosophical assumption, as I noted earlier, upon which all types of qualitative research are based is the view that reality is constructed by individuals interacting with their social worlds" (Merriam, 1998, p. 6). Merriam maintains that the primary interest of researchers is to understand the ways people make sense of their world and their experiences in it. She also suggests that researchers develop a sensitivity that extends to understanding how biases or subjectivity shapes investigation and findings. Since there are multiple interpretations of reality, the researcher "brings a construction of reality to the research situation, which interacts with other people's constructions or interpretations of the phenomenon being studied. The final product of this type of study is yet another interpretation by the researcher of others' views filtered through his or her own" (Merriam, 1998. p. 22). Therefore, in a later section I will disclose my subjectivity as a researcher.

Research Site

The site for this study was one fourth-grade science classroom in a charter school located in an urban area in Arizona. The K-4 charter school, which I will call Sugar Street Elementary, served approximately 387 students, with 68.7% identifying as Hispanic/Latino, 14.0% Black/African American, 10.9% White, and the remaining 6.4% a combination of Asian, American Indian/Alaska Native, and Two or More Race Categories. The academic curriculum used by Sugar Street was based on the Arizona's College and Career Readiness Standards.

The fourth-grade science classroom in which I collected the data for this dissertation had 27 students, among whom 14 were listed as Hispanic/Latino, 9 White, and 4 Black/African American. Three students in this classroom were identified as ELLs by their performance in the Arizona English Language Learner Assessment (AZELLA) and received English Language Development (ELD) instruction Monday through Thursday at the end of day from 2:55pm to 3:30pm during the intervention time scheduled by the school. All three students were included as my case study students. Typically, the structured English immersion (SEI) model adopted by the state mandated a four-hour model, according to which ELLs were segregated from the mainstream population to spend four hours a day learning English. However, as Sugar Street Elementary had a very small number of ELLs (i.e., less than 20 across different grades), they provided ELLs with instruction through the development of Individual Language Learner Plans (ILLPs). According to the focal ELLs' home classroom and English language arts teacher, Mrs. Bain (pseudonym), the ILLPs standards were shared by the content teachers such as math and science, thus the ELLs received the ELD instruction throughout the day. During the intervention time at the end of the day, the ELLs were supported in language areas such as reading and fluency according to their individual needs.

Participants

The Science Teacher

Ms. Reed (pseudonym), a Caucasian fourth-grade science teacher at Sugar Street Elementary, was in her first year of teaching science. She had a K-8 elementary education general certification and the National Evaluation System Middle Grade Science certification. She recieved a Bachelor of Arts in elementary education. When she was studying at her university in a northwestern state, she took astronomy, worked as a research assistant in the agriculture department and had experience in data collection and presentation of data. She thought her insights about the inquiry process gained through working as a research assistant in college could benefit her students. She reported that she tried to make sure her students not only engaged in hands-on experiences but also had opportunities to discuss things with each other, use the science vocabulary, ask questions, and draw conclusions that might not necessarily be accurate.

The Case Study Students

Camila. Camila (pseudonym) was a shy female Latinx student. She scored "intermediate" across the four language skills (i.e., reading, writing, listening, speaking) on AZELLA in April, 2019. Apart from the ELD intervention, she also received speech services. She started attending Sugar Street Elementary in the third grade. Her home classroom teacher, Mrs. Bain, who was also in charge of the focal ELLs' ELD intervention, reported that Camila could participate in class orally but needed support in vocabulary and writing. Camila spoke two languages – Spanish and English – at home. She had two older sisters studying in high school. Sometimes when she noticed me enter the science classroom, she would give me a gentle smile. When I told her that I was from China, she told me that her father worked at a Chinese restaurant and taught her some Chinese words. In the science class, Camila stayed concentrated when she was taking notes and often volunteered to help the teacher distribute instructional materials and help her peers with their science fair project experiments. For example, she and Audrey once volunteered to help Kelly swab a dog and a lizard in another science teacher's classroom.

Lucas. Lucas (pseudonym) was a male Latinx student. He scored "pre-emergent/emergent" in reading and writing and "intermediate" in listening and speaking on AZELLA in April, 2019, so his overall performance was at the basic level. He had attended Sugar Street Elementary since first grade. Although Lucas was very proficient in oral English, as Mrs. Bain claimed, his performance on the state English Language Learner Assessment had been consistent and not making progress over the years, which had raised concerns for her. Mrs. Bain reported that Lucas needed support in reading comprehension and writing and that he missed a lot of school. During my data collection, I also noticed that Lucas was often late for class. Socially, Lucas was a student who liked to help others. He volunteered to help Ms. Reed clean the pieces of a broken flask in class and helped a child carry a heavy box during lunch recess.

Felipe. Felipe (pseudonym) was a male Latinx student. He scored "pre-emergent/emergent" across the four language skills on AZELLA in April, 2019. He was born in Mexico and lived with his uncle and aunt. He started school the U.S. in the middle of the third grade. At the beginning of the fourth grade, he transferred to Sugar Street Elementary. Mrs. Bain, whose heritage language was Spanish, reported that Felipe went to several schools while he was in Mexico, so he had never really developed a strong base in his native language. She reported that Felipe struggled with antonyms in Spanish and phonetics. According to Mrs. Bain, Felipe had to read her his writing in Spanish for her to understand, and his reading was at the first-grade level and he relied heavily on picture cues. Socially, Felipe had friends who were able to offer support by explaining things in Spanish to him, as Mrs. Bain mentioned. Ms. Reed described Felipe as a smart student and expressed that when he had internal motivation to learn something, he was ready to take off.

Data Sources and Collection

Data collection for this dissertation lasted for a two-month period from March 2019 to May 2019. I collected multiple forms of data for my study: interviews with focal ELL students, video recordings of science instruction, and documents. I describe in this section how these forms of data were collected and matched my research questions (see Table 1 for a matching relationship among my research questions and data sources).

Table 1

Matching Relationship Between Data Sources and Research Questions

	RQ 1: What are the common classroom procedures present in this fourth-grade science classroom and what are the celebrated and marginalized practices within these procedures?	RQ 2: What science-related identities do focal ELLs develop through classroom interactions?	RQ 3: How do the focal ELLs perceive themselves as science learners?
Interviews with focal ELLs			√
Video recordings of science instruction	√	√	
Documents	√	√	

Interviews

Interviews involve asking, listening, and interpreting (Mason, 2002). Formal interviews with the focal ELLs were an important source of data in my study. They offered insights about how they perceived themselves as scientists and science students.

The “ELLs’ Self-perception as Science Learners” interview protocol (Appendix A) I used to investigate their self-perceived science identity was semi-structured and included questions that centered on students’ routine classroom experiences and out-of-school experiences with science. Questions in this interview were adapted from Kane’s (2012, 2015) “Being a Scientist” and “Studenting” interview protocols. The formal interview with the focal ELLs was administered two times: one at the beginning of my data collection and the other near the end of my data collection. During the initial and final interviews, Camila, Lucas, and Felipe were given the opportunity to narrate events in their lives, such as describing a time when they thought of themselves as a scientist and science learning experiences inside and outside the school. While Part 1 of the interview protocol focused on how students perceived themselves as a scientist, Part 2 of the protocol focused on how they perceived themselves as science students in their classroom. Questions in Part 2 were concerned with the focal students’ feelings about school and the science classroom, their own description of themselves as science students, who they identified as a good science student in the classroom, their experiences of working on science projects alone and collaborating with others, and how their perceptions of themselves as science students might have changed overtime. During the initial interview with Felipe, I invited his home classroom teacher Mrs. Bain to offer Spanish-English translation help. Mrs. Bain assisted with my interview by translating my questions into Spanish to Felipe. And when Felipe felt more comfortable responding my questions in Spanish, Mrs. Bain translated his responses into English so that I could understand them. During the final interview with Felipe, Felipe expressed that he could do the interview without Mrs. Bain's help, so I respected his choice and let him complete the interview on his own.

Observations with Video Recording

Observations take place in natural field setting and represent a firsthand encounter with phenomenon of interest rather than a secondhand account of the world provided in interviews (Merriam, 1998). Observations of science instruction occurred three to four times a week in Ms. Reed's classroom for two months, totaling approximately thirty observations of the 60-minute science session. Observations allowed me to better understand the teacher's instructional approach, classroom routines and norms, the ways that students participated in class, how the teacher and the students interacted, and how the students interacted with each other. My strategies of video recording varied based on the kinds of instructional activities going on in the science session. During whole-group lessons such as lecture and teacher-guided notetaking, I used the camera to capture what was going on within the whole class. During instructional activities that involved table group interactions (e.g., a table group discussion and a Jeopardy quiz that allowed table members to share answers with each other), I used two cameras to focus on two of the case study students at a time, recorded student-to-student interactions at their respective tables for ten to fifteen minutes, and then moved one of the cameras to a third case study student's table and recorded their interactions for the similar length of time. While a camera focused on the activities going on at a table, I also placed a microphone in the center of the table to better record students' voice when they interacted with each other. The students could easily notice the camera and the microphone that focused on them, but the distraction lasted only briefly. After I completed the data collection, I viewed each day's video recordings to catalogue the video data. In the classroom video logs that I kept, I wrote running narratives of what transpired in each video episode, which included information about the location of ongoing activities, timestamps, how the participants acted and reacted, and excerpts of conversation transcriptions (see Appendix B for transcription conventions).

Documents

I collected documents such as photos of the students' notebook pages, the students' slideshows for their science fair projects, instructional materials (e.g., foldables, packets), and classroom artifacts. These documents served as a form of data to inform my analysis of common classroom procedures (relevant to RQ 1) and the classroom interactions in which focal ELLs participated in (relevant to RQ 2).

Data Analysis

RQ 1: What are the common classroom procedures present in this fourth-grade science classroom and what are the celebrated and marginalized practices within these procedures?

The objective of this first phase of analysis was to identify and describe practices present in Ms. Reed's classroom as well as to understand the celebrated and marginalized ways of participating in these practices. The primary data sources for this phase include classroom video logs and transcriptions of classroom interactions. The classroom video logs recorded what transpired in the classroom during observation and partial transcriptions of conversations were segmented into events, which Bloome et al. (2005) define as "a bounded series of actions and reactions that people make in response to each other at the level of face-to-face interaction" (p. 6). Typically, change in participants, the topic under discussion, and instructional activities signaled the beginning or end of an event. A total of 265 events were identified in the classroom video logs. For the first step in this phase of analysis, I conducted open coding to identify emerging classroom procedures in events. Below, Table 2 presents the list of identified classroom procedures and their definitions.

Table 2

List of Identified Classroom Procedures

Procedure	Definition
Lecture	The teacher delivers explanation of scientific concepts or instructions for students to follow. During lecture, students play the role of listener.
I-R-E procedure (Cazden, 2001)	The interactional pattern between the teacher and the whole group that follows the structure of "teacher initiation, student response, teacher evaluation" (Cazden, 2001)
Guided notes	Notetaking sessions which take place during lecture. The teacher reads notes on the projector screen or the white board for students to copy down.
Jeopardy	A quiz that involves competition among student table groups and serves the purpose of knowledge review before an end-of unit test.
Table group discussion	Table group members discuss about questions or topics assigned by the teacher. The length of discussion is usually brief, ranging from 20 seconds to 10 minutes.
Independent work	Students work on assigned tasks independently, following the instruction given by the teacher.

For the second step of analysis, I read through instances of each common classroom procedure in the video logs. I then adapted Carlone's (2012) descriptive question matrix to guide my analysis and thick description (Geertz, 1973) of representative examples of classroom practices. Based on the guiding questions from Carlone (2012), I used both open codes and a priori codes to code for the celebrated/marginalized ways of participating, actors, time, space, tools, talk, acts, artifacts, and purpose(s) (see Table 3 and Table 4). The forms of evidence that I used to examine celebrated and marginalized practices within each classroom procedure include:

- Celebrated practices:
  - praise and encouragement from the teacher or peers (Carlone, 2012)
  - teacher's talk about behavioral expectations
  - discipline practice by the teacher or peers
- Marginalized practices:
  - discipline practice by the teacher or peers
  - correction from the teacher or peers (Carlone, 2012)
  - teacher's neglect of student questions or input

Table 3

Categories and Questions Guiding the Description of Common Classroom Procedures (adapt from Carlone, 2012) and Coding Scheme (Part 1)

		Descriptive Codes		
Ethnographic analytic categories	Questions	Lecture	I-R-E procedure (Cazden, 2001)	Guided notes
Celebrated practices	What are normative and celebrated ways of participating in the procedure?	Listening, facing the teacher, raising hand to bid to speak	Raising hands to bid for the floor, telling the right answer	Facing the teacher, holding the pencil, keeping hands still, writing/copying notes, listening, putting pencils down when finishing writing, being patient and not distractive when finishing writing, raising

				hand when there is a problem, asking clarification questions
Marginalized practices	What are marginalized ways of participating in the procedure?	speaking while the teacher speaks, turning away from the teacher, having side conversations, not following the teacher's instructions	Having side conversations, speaking without the teacher's nomination when an I-R-E sequence ends, nonparticipation	Refusing to write when required to do so, having side conversations while writing, asking questions about writing instructions
Actors (central and marginal)	Who participates in this practice?	The teacher and whole group	The teacher and whole group	The teacher and whole group
Time	What are the times that the procedure take place? How often?	Throughout each science unit, very often	During lecture or collective unit review, very often	During lecture, very often
Tools	What tools are used?	PowerPoint, projector		Projector, PowerPoint, white board
Talk/interactional pattern	What kind of talk is used in this procedure?	Teacher monologue (Gibbons, 2006), I-R-E (Cazden, 2001)	Teacher initiation/student response/teacher evaluation, i.e., I-R-E (Cazden, 2001)	Teacher monologue (Gibbons, 2006), I-R-E (Cazden, 2001)
Acts	How do actors act in this procedure?	The teacher: holds the floor; draws visuals on the white board; checks if		The teacher: Reads and repeats sentences on the PowerPoint slides/white board for

		students follows along Students: Listen; confirm that they are following along		students to copy down; reminds students of behavioral expectations; explains scientific concepts/delivers teacher monologue; responds to students' questions or proposed ideas (e.g., "Turn the battery the other way? That is actually a very good idea."); asks questions and gives evaluation (I-R-E pattern); checks students' notes; gives directions for notetaking Students: Write notes; respond to teacher's questions (I-R-E pattern); occasionally asked the teacher questions relevant to the content of notes
Artifacts	What artifacts are produced in this procedure?			Notes, foldables/graphic organizers cut and pasted into notebooks

Purpose(s)	What is the purpose(s) of this procedure?	To give instruction, to introduce new scientific concepts	To check if students know something	To enhance knowledge retention

Table 4

Categories and Questions Guiding the Description of Common Classroom Procedures (adapt from Carlone, 2012) and Coding Scheme (Part 2)

		Descriptive Codes		
Ethnographic analytic categories	Questions	Jeopardy	Independent work	Table group discussion
Celebrated practices	What are normative and celebrated ways of participating in the procedure?	Writing down the right answer, telling the right answer verbally	Following the teacher's task instructions, completing a task independently	Writing down the correct answer, showing one's knowledge of science facts
Marginalized practices	What are marginalized ways of participating in the procedure?	Peeking at/eavesdropping another group's answer	Playing with experiment materials, moving around the classroom, watching others doing their experiment rather than doing the assigned tasks, making noise and disturbing others, asking the teacher to repeat her instructions halfway	

			through independent work, asking questions irrelevant to task completion	
Actors (central and marginal)/participation structure	Who participates in this practice?	Teacher and the whole group	Students (as central) and the teacher (as marginal, facilitating student work)	Table group members
Time	What are the times that the procedure take place? How often?	End of a science unit	Continues throughout the science fair project unit, after the teacher assigns tasks and delivers her instructions	During jeopardy, before whole group I-R-E in regular lessons
Tools	What tools are used?	Projector, PowerPoint, mini white boards	Science fair planning packet, laptops, experiment materials and tools	Worksheet with task instructions (sometimes)
Talk/interactional pattern	What kind of talk is used in this procedure?	I-R-E, sharing answers (table group members)		Taking turns to share ideas
Acts	How do actors act in this procedure?	Teacher: Announces questions based on student choice; checks student answers on their mini white boards group by group; announces and shows the right	Teacher: Provides individual instructions; answers students' questions; repeats instructions if necessary	

		answer on the projector screen; legitimizes student answers; asks students to justify their answer if they have a wrong one; assigns points to each table group Students: Whisper answers to questions within their table groups; write down answers on mini white boards; show their answers to the teacher; prevent exposing the answer to another group by covering it; correct another group member' answer on the mini white board; accuse another student for cheating; covers the answer after writing it down	Students: Follow instructions; ask for help from the teacher or table group members; offer help to table group members	
Artifacts	What artifacts are produced in this procedure?		Data table, notes on background research, list of materials, photos as records of	

			experiments, PowerPoint slides, display boards	
Purpose(s)	What is the purpose(s) of this procedure?	To prepare for end-of-unit tests, to review knowledge	To do background research, investigation, and prepare presentation for science fair projects	

RQ 2: What science-related identities do focal ELLs develop through classroom interactions?

Identity as position (Davies & Harré, 1990) was an important concept that guided my analysis of Research Question 2. A position, as Harré (2011) defines, is “a cluster of rights and duties recognized in a certain social milieu” (p. ix). Green and her colleagues (2020) state that how individuals take on or reject situationally constructed positions varies according to each unique actor and her/his background, experiences, and goals in developing events of classroom life. My analysis of Research Question 2 involved three major steps. First, I used open coding to generate codes from the classroom video logs for positions that my case study students assumed and were assigned and their definitions (see Table 5).

Table 5

Open Codes for Positions

Positions	Description
Competent student	Was encouraged or complimented by other students before or during the jeopardy quiz (i.e., “I know you can do this.”), was praised by the teacher when telling a right answer

Student who needs help	Copied or asked for an answer from a more competent table member during jeopardy, asked, asked for academic help (e.g., word spelling) from a more competent student
Answer guardian	Accused a student from neighboring table for eavesdropping during Jeopardy
Agreeable student	Mostly listened to others and expressed agreement throughout a table group discussion
Behavioral monitor	Pointed out others' off-task behaviors
Incapable student	Was offered help when it was not requested, his/ her independent task was taken over by others, his/her suggested answer during jeopardy was ignored or corrected by table group members, the teacher repeated instructions for him/her
Competent Spanish user	Tested if others could speak or read Spanish (e.g., "How do you say XXX in Spanish then?)
Nonwriter	Did not meet the teacher's expectation to write in English
Uncooperative student	Was admonished for not meeting classroom behavioral expectations or doing what she asked, was pointed out by other students as "messing around", unmotivated to engage classroom activities (e.g., zoned out during notetaking)
Compliant student	Met the teacher's expectation, performed assigned task

Second, I selected out representative events for each position that my case study students assumed or were assigned. These representative events were typical in terms of the ways in which acts of positioning occurred and how individuals acted and reacted to each other. Following Bloome et al.'s (2005) way of doing microethnographic discourse analysis, I transcribed video recording data of the representative events into verbatim and contextualization cues (Green & Wallat, 1981)—verbal, nonverbal and prosodic signals that make people's intentions known during interaction, including pause, volume shifts, stress, gestures, facial expression, etc. I broke verbatim into message units, which is the smallest unit of conversational meaning and signaled through participants' use of contextualization cues such as pause, stress, intonation, and change of volume. A level up from the message unit is an interactional unit which is bounded by the participatory demand (e.g., a question-answer interaction) and signaled by the syntax of a message unit as well as contextualization cues.

In the third step, I analyzed focal ELLs' science identity formation in classroom interactions using the "Description of Social Identity" chart in Bloome et al. (2005), which pays attention to language use as people name, construct, contest, and negotiate positions within a language and literacy event (see Table 6 for an analysis example).

Table 6

Analysis Example of Description of Science Identity (Bloome et al., 2005)

Line no.	Speaker	Message unit	Nonverbal behaviors	Position	Linguistic evidence
1	Felipe	I'm done.		Compliant student, writer	"Done" signaled his completion of the assigned task of writing down experimental procedures for his science fair project
2	Ms. Reed	Oh you are doing so good. Ok, Ok, these are all in Spanish. You know that I can't read Spanish, right?	 read Felipe's writing	Positioned Felipe as compliant student Positioned Felipe as nonwriter in English	Praised Felipe for completing a task she had asked him to do Pointed out his use of Spanish in writing Indicated that writing in Spanish was unacceptable and the rule of using English only
3	Felipe	Yes XXX		Nonwriter	Confirmed, accepted that using Spanish was not acceptable
4	Ms. Reed	So when you put them on your PowerPoint,		Positioned Felipe as capable of	Confirmed if Felipe was going to type in English in his PowerPoint slides for

		are they gonna be in English?		writing in English	the science fair presentation, reinforced the rule of using English only
5	Felipe	Yes XXX put right there		capable of writing in English	Accepting
6	Ms. Reed	Ok, so how far did you get? What step are we at? So we put water in the container, all three containers, right? Then we're gonna take each of our rocks and put them in the containers What, how are we gonna tell how much water gets absorbed? How do you think?	using gestures to show this step Felipe nodded	Positioned Felipe as nonwriter, and herself as teacher	Though Ms. Reed asked Felipe's current progress, she did not offer Felipe the floor to speak about what he had written down and immediately continue to go through the experiment procedure herself. Initiated an I-R-E sequence by asking questions
7	Felipe	Uhh XXX		Positioned himself as student	Responded to Ms. Reed's questions
8	Ms. Reed	Yeah, exactly.	Felipe nodded	Positioned Felipe as competent Reed Positioned	Positive evaluation of Felipe's answer Continued her monologue on more

		So if you have a cup full of water right? And you drop a rock in it, does it usually get higher and kinda spill out over the edges right?	use gesture to show "spill out"	Felipe as student	steps in the experiment procedure Nodding by Felipe signaled listenership
9	Felipe		nodded	Positioned himself as student	Responded to the teacher's question

RQ 3: How do the focal ELLs perceive themselves as science learners?

The analysis of this research question relied on the data source of the focal ELLs' interview transcripts. I adopted initial coding and pattern coding from Saldaña (2013). First, initial coding was done line by line. I generated codes to interpret the focal ELLs' descriptions of their actions, others' actions, attitudes and feelings (about science, about other students, about the science teacher, about the science classrooms, about self), definitions of what scientists do, moments when they perceived themselves as scientists, and so forth. Second, these initial codes were grouped into pattern codes, which were then used to develop emergent themes.

Researcher Subjectivity

My positionality as an international doctoral student from China inevitably influenced my way of approaching research. Before my masters and Ph.D. education, I received primary, secondary, and college education all in China. Therefore, for the students, the science teacher, the science classroom, and the school in which I conducted my dissertation study, I was an outsider. However, as a doctoral student interested in second language and literacy learning as well as equity issues concerning the education of ELLs, I hoped to cultivate a collaborative relationship with the participant teacher. Spindler (1982) contends that since school is familiar to all, the task of a school ethnographer is to make the familiar strange, in opposition to anthropologists' job to make the strange familiar. However, my research process involved both a process of making the strange familiar - that is, familiarizing myself with the setting in which I conducted my study - and a process of making the familiar strange. Furthermore, growing up in a family which has achieved a middle-class status in China puts me in a privileged status compared to the language minority students who became my focal students and whose family might suffer economic difficulties or hardship in various aspects of life that I might not be able to imagine. Meanwhile, I also realized what I had in common with the focal ELLs. As a second language learner in higher education setting myself, I experienced the difficulties of socializing in the academia in a language other than my mother tongue and navigating in the graduate school, and I was quite aware of the differences between me and my English-speaking classmates and mentors. As an international student who learned to straddle two cultures and strived to become a more confident beginning researcher in a western institution, I was curious to hear ELLs' voices about who they were becoming in science - a challenging subject area in terms of conceptual understanding and academic language – and positioned their experiences in the science classroom as the center of my inquiry.

CHAPTER 4

FINDINGS

Introduction

In this chapter, I provide the findings to my research questions. Drawing on the data collection and data analysis procedures found in the previous chapter, I present detailed findings related to each of the following research questions in order to examine how three case study ELLs identified with and in science:

> RQ 1: What are the common classroom procedures present in this fourth-grade science classroom and what are the celebrated and marginalized practices within these procedures?
>
> RQ 2: What science-related identities do focal ELLs develop through classroom interactions?
>
> RQ 3: How do the focal ELLs perceive themselves as science learners?

Research Question 1: Common Procedures Present in the Classroom

Drawing on data primarily from classroom video recordings, this section seeks to address Research Question 1:

> What are the common classroom procedures present in this fourth-grade science classroom, and what are the celebrated and marginalized practices within these procedures?

In this section, I address my first research question by describing what each classroom procedure looks like and using representative examples from classroom video recordings. Below, Table 7 summarizes the six procedures I identified in Ms. Reed’s science classroom, including lecture, I-R-E procedure, guided notes, Jeopardy, independent work, and table group discussion. After the general description and the representative example of each identified procedure, I will also illustrate celebrated and marginalized practices within them.

Table 7

List of Identified Classroom Procedures and Count

Procedure	Definition	Number of events involving the procedure
Lecture	The teacher delivers explanation of scientific concepts or instructions for students to follow. During lecture, students play the role of listener.	42
I-R-E procedure (Cazden, 2001)	The interactional pattern between the teacher and the whole group that follows the structure of "teacher initiation, student response, teacher evaluation" (Cazden, 2001)	74
Guided notes	Notetaking sessions which take place during lecture. The teacher reads notes on the projector screen or the white board for students to copy down.	12
Jeopardy	A quiz that involves competition among student table groups and serves the purpose of knowledge review before an end-of-unit test.	31
Table group discussion	Table group members discuss about questions or topics assigned by the teacher. The length of discussion is usually brief, ranging from 20 seconds to 10 minutes.	5
Independent work	Students work on assigned tasks independently, following the instructions given by the teacher.	11

Lecture

Overview of lecture. I define the lecture procedure in Ms. Reed's classroom as classroom interactions in which the teacher held the floor to introduce and explain new scientific concepts to the students or to give specific task directions. During lecture, students were expected to pay attention and listen. The interactive pattern between the teacher and students was similar to what Gibbons (2006) describes as "teacher monologue", in which the teacher holds the floor for one and two minutes without interruption and does not seek to elicit verbal response from students. Occasionally, students raised up hands to ask questions or speak about the connections they made with the delivered scientific knowledge, and their questions or input did not always receive the teacher's response. The lecture procedure in Ms. Reed's classroom was usually followed by the Initiation-Response-Evaluation pattern (Cazden, 2001) so that the teacher could check immediately if students were listening and following along and understood the knowledge being taught. There were 42 instances of lecture identified in the classroom video recording data.

Representative example of lecture. Below, Ms. Reed explained to the whole group how lightning happens during a lesson on static electricity.

Excerpt 4.1

Ms. Reed: Ok, the bottom of a cloud gains a negative charge and how this happens, um, well I guess that (i.e., the text on the PowerPoint slide) doesn't explain it. This creates a positive charge on the ground, so clouds are basically a representation of / Instead of rubbing our socks on the carpet and then touching a door handle, we are talking about the cloud being our hand basically, and the ground being the door handle. So when lightning strikes from a cloud, all that's happening is a giant version of your hand sparking towards the door handle, Ok? (Briefly stopped)

Kevin: Except the current XXX

Ms. Reed: (continued explanation) When the charge's strong enough, the charge jumps from the ground to the lightning. So what I'm trying to tell you is this. Do you see this cloud right here?

Ss: Yeah.

Ms. Reed: There is way too many side conversations. (Stopped speaking and waited) Turn your whole body towards me please. Thank you. (continued with explanation and drawing visuals on the board) So these clouds are gonna be pulling electrons from the atoms in the sky, right? So we have a plus and a minus in this side, and a plus and a minus in this one (drew on the white board). And this cloud is stealing electrons.

> It is trying to take this and move it up here, so we have a whole bunch of electrons in the cloud. And what we are left with down in the air and on the ground is just the protons, Ok? Just the positive.
>
> (classroom transcript, 3.22.19)

During her explanation, the only student response that Ms. Reed elicited was to confirm that they were able to see the illustration of lightning on the PowerPoint slide. Ms. Reed also reminded the students to face her and stop side conversations while she held the floor.

Celebrated practices. The practices of facing the teacher and listening were the norms for participating in the lecture. These practices were sometimes reinforced by the teacher's discipline practice (e.g., "There is way too many side conversations. Turn your whole body towards me please."). In addition, students needed to raise up hand to ask questions relevant to the content being delivered by the teacher.

Marginalized practices. During lecture, the practices below were marginalized:

- Having side conversations
- Turning away from the teacher
- Speaking while the teacher speaks

The practice of speaking while the teacher speaks was marginalized often through the teacher's neglect of student input or reminder about the norm of listening (e.g., "Please just listen."). For example, the excerpt below shows how Ms. Reed ignored Pearl's proposed connection while explaining the use of electromagnet on cranes:

Excerpt 4.2

Ms. Reed:	(read the text on the next slide) Some cranes have electromagnet that can pick up heavy loads of iron or steel. (explained the picture of a crane on the slide) So XXX the actual claw in the end, they have just basically a big,

	usually they are round, sometimes they stick a little bit further than the one in the picture you see there.
Pearl:	(spoke without nomination, loudly) Like the trucks that pick up the cars!
Unknown student:	Yeah.
Ms. Reed:	(continued with explanation) They also place a lid sometimes right there.
Pearl:	(spoke without nomination) Like the trucks that pick up the cars.
Ms. Reed:	(continued to read the text on the slide) When the operator turns the electromagnet off, [stuff] drop to the ground. So it's pretty beneficial to be able to turn it on and off. If you wanna get stuff off your giant magnet, and it was always on, would it be kinda difficult?
Students:	Yeah.

(classroom transcript, 4.1.19)

Although I present the transcript data in a turn-taking fashion, Pearl took chances to speak during short pauses in the teacher's monologue. Her multiple attempts at making connections between the teacher's explanation and her experience of seeing crane trucks in real life (i.e., "Like the trucks that pick up the cars.") were ignored by Ms. Reed. The teacher carried on her lecture without inviting Pearl to share and elaborate her connection with the whole group. This excerpt suggests that the norm of participating in guided notes was to listen quietly. If a student reacts to the teacher's lecture actively and speaks without the teacher's permission, he/she probably would be ignored.

In addition, students received criticism when the teacher perceived that they were not following her instructions strictly during lecture. For example, when Ms. Reed saw Joseph did not cooperate with her instruction of circling the right answer to a question in a practice test, she took away one dojo point (i.e., a behavioral management system that Ms. Reed used to deduct points from individual students as punishment when they failed to fulfill classroom behavioral expectations) and reprimanded him by saying, "Joseph, this is your warning. You need to be doing what I'm asking you to do. All you have to do is to circle things."

I-R-E (Initiate-Respond-Evaluate) Procedure

Overview of the I-R-E procedure. In Ms. Reed's classroom, the I-R-E procedure was the most frequent procedure, and there were 74 instances identified in the classroom video recording data. Multiple scholars who have studied this interactive pattern argued that it conveys to the students that there is a single valid answer to every question and that the teacher is the sole validating authority (Cazden, 2001; Engle & Conant, 2002; Lemke, 1990; Mehan, 1979). The purpose of this procedure was to check if students remembered the scientific knowledge being taught or to see if they had the correct answer to a question. Thus, the questions asked by Ms. Reed were mostly test questions (Mehan, 1979) with prescribed answers.

Representative examples of the I-R-E procedure. I will show two examples here to demonstrate how Ms. Reed used the I-R-E procedure. The first example took place during a lesson in which the class collectively reviewed scientific concepts learned in the static electricity unit, which included conductors, insulator, electrons, and protons.

Excerpt 4.3

Ms. Reed: Protons are the positive parts of an atom (pointed the illustration of an atom on the whiteboard), right? The green ones (pointed to the illustration of an atom on the white board). Do protons jump away or did they stay still? Someone raise their hand and remind me, do protons move or do they stay? Hang on. I only see two or three hands right now. Abigail?

Abi: They:: they move cuz atoms jump from one place to another.

Ms. Reed: Ok, that's not quite right but you are so close. You are so close. So the whole atom is not gonna jump. One piece of an atom is going to jump. One piece of an atom is going to jump. Kevin.

(Kevin kept holding up his hand while Ms. Reed talked.)

Kevin: The electrons, cuz they are outside the atoms.

Ms. Reed:	Right. So the electrons are the pieces that jump. (continued with lecture/collective review) So protons and neutrons stay in the nucleus together…

(classroom transcript, 3.21.19)

In this excerpt, immediately after Ms. Reed explained the characteristics of protons, she solicited answers to the question "Do protons move or do they stay?" She sought the students' attention (i.e., "Hang on.") and reminded them to raise up their hands to participate. After Abi told her answer, Ms. Reed refuted the accuracy ("that's not quite right") but acknowledged her effort to answer the question (i.e., "you are so close"). Ms. Reed then continued to solicit the right answer from students by offering an additional hint (i.e., "One piece of an atom is going to jump."). When Kevin was nominated and offered the correct answer, Ms. Reed gave the positive evolution (i.e., "Right.") and carried on with her explanation of protons and neutrons.

The second example happened when Ms. Reed modeled for the whole group how to develop a data table based on the question "How does speed that you run affect your heart rate?" In this example, Ms. Reed elicited multiple students' ideas on how to title the table.

Excerpt 4.4

Ms. Reed:	What would you guys like to title it?
Unknown student:	STEM.
Unknown student:	STEM.
Unknown student:	Yeah, STEM.
Ms. Reed:	No:: It needs to be related.
Unknown student:	Chart XXX
Martin:	Speedy rate.

(Multiple students talked at the same time. Ms. Reed was looking at her laptop.)

Ms. Reed:	Ok, anybody? Raise your hand, please. Jennie.
Jennie:	XXX
Ms. Reed:	Speed rate? Ok:: What do you say, Callie?
Callie:	Heartrate while running (raising intonation).
Ms. Reed:	Heartrate while running. I like both of those. Jay.

Jay:	XXX
Kevin:	(put down his raised hand and spoke after Ms. Reed looked at him) Speedy running.
Ms. Reed:	No. Sophie.
Sophie:	Effect on running.
Ms. Reed:	Effect on running. I like it. It put all these together. Pearl.
Pearl:	Heartrate chart.
Ms. Reed:	Ok. I like that. XXX Audrey.
Audrey:	Heartrate data table.
Ms. Reed:	Heartrate data table. Ok, guess what, those are really good. So heartrate data table works for me, if you like. (raised her voice) I wanna title mine (writing the title on the board) "How running affects heartrate". That's mine.
Kevin:	AKA speedy run.
(Some students laughed.)	
Ms. Reed:	So scientists are lazy and they just like to just make things what they are. My title is what it is, right?
Unknown student:	Scientists are [lazy].
Ms. Reed:	They sure are. That is a rule that you should know going forward. They like to write down what is necessary and leave out all unnecessary information.
Unknown student:	But why?
Ms. Reed:	Because in science you need to know things to the point. We don't need extra details as in ELA. We don't need to know things in any narrative fancy form. We have no emotions here. It's facts, objective. (signaled Kevin to be quiet)

(classroom transcript, 4.23.19)

Multiple students shared their ideas for the table title (e.g., speed rate, affect on running, heartrate while running) and Ms. Reed made the following comments to their ideas: “I like both of those.”, “I like it. It put all these together.”, “I like that.”, “those are really good.” Though the comments were positive, they seemed to acknowledge students’ participation and the effort that they put into answering the question rather than their intellectual contributions. For each student suggestion, Ms. Reed did not recognize the logic behind it and why they would put certain words together to form a title. Although she approved Audrey’s “heartrate data table” as somewhat appropriate (i.e., “So heartrate data table works for me, if you like."), she announced her own answer and positioned it as authoritative by writing it on the white board. She then positioned herself as belonging the scientist community by juxtaposing her table title with what scientists do (i.e., "So scientists are lazy and they just like to just make things what they are. My title is what it is, right?"). She then used the pronoun "you" to refer to students and "we" to refer to herself and the scientist community, positioning students as novices outside of the scientific community who need to follow the rules of "knowing things to the point" and reporting things objectively without "extra details as in ELA".

This second example implies that although sharing ideas was encouraged and celebrated in Ms. Reed's classroom, the scientist identity was out of the students' reach. It was very hard for students to be recognized as being scientific. The students were held accountable for expressing their ideas and participating in whole-group conversations, but their intellectual input was not recognized by the teacher. Rather, the teacher had access to knowledge possessed by the scientist community and positioned her answer as scientific and authoritative.

Celebrated practices. Within the I-R-E procedure, the practice of raising hands to bid for the floor was the norm for participation by individual students. When multiple students responded to the teacher's question simultaneously, the teacher would reinforce this norm by saying, for example, "Raise your hand, please." Telling the right answer was celebrated through Ms. Reed's praise, such as "Yeah, very good! You remember that insulators hold onto their electrons." and "You are correct! Good job.", or through her approval (e.g., "Right.", "I agree with that.", or repeating the student's answer loudly).

Marginalized practices. During the I-R-E procedure, the following practices were marginalized in Ms. Reed's classroom:

- Speaking without the teacher's nomination when a question is asked
- Having side conversations
- Speaking without the teacher's nomination when an I-R-E sequence ends

The first representative example shown above has illustrated how speaking without the teacher's nomination during I-R-E was marginalized as the teacher noticed the majority were not raising up their hands to bid (i.e., "Hang on. I only see two or three hands right now."). When the whole group and Ms. Reed were engaging in the I-R-E procedure, Ms. Reed would shush the students who talked to their peers without her permission and give them a warning (i.e., "This is your warning."). In addition, speaking without the teacher's nomination when an I-R-E sequence ended could lead to being ignored by the teacher. For instance, the example below showed Kevin's suggestion to test out whether nickel is magnetic was ignored by Ms. Reed. As soon as Ms. Reed ended the I-R-E sequence focused on the question "Will a silver money get picked up by a magnet?", she continued her lecture without addressing Kevin's suggestion.

Excerpt 4.5

Ms. Reed:	No, not really. Unless for some reason there is a lot of nickel inside of a penny because pennies are nickel XXX inside of copper. Ok? They are not entirely made of copper. They have a little bit inside of them, but it's unlikely they'll magnetize. Will a silver money get picked up by a magnet?
Students:	Yes.
Ms. Reed:	Yes, yes. Ok.
Students:	(chatted to each other)
Kevin:	Let's test out with the nickel.
Ms. Reed:	This is found all around a magnet, but it is strongest at the ends of the poles. So on your picture, what you can do on the ends of the poles… (continued lecture and gave instructions)

(Classroom transcript, 3.29.19)

Guided Notes

Overview of guided notes. The guided notes procedure in Ms. Reed's classroom involves students taking notes under the teacher's instruction. During guided notes, the teacher reads and repeats sentences, often scientific facts with key terms for students to remember, on the projector screen or the white board for students to copy down. The main artifacts produced in this procedure were foldables with key scientific vocabulary and illustrations that students cut and pasted into their notebooks. Figure 1 shows an example of foldables used in the magnet unit. Students were expected to write down the exact sentences and terms in the right location in the foldables as demanded by the teacher. Guided notes usually co-occurred with lecture and the I-R-E procedure, as the teacher often delivered an explanation on scientific concepts relevant to the sentences (often the definition of scientific terms, such as magnetic field, and science facts) that students were going to copy down and checked the students' understanding of the knowledge she just lectured about or the sentences to be copied. During guided notes, students were observed to be busy writing mostly. They were slow at responding to Ms. Reed's questions while writing.

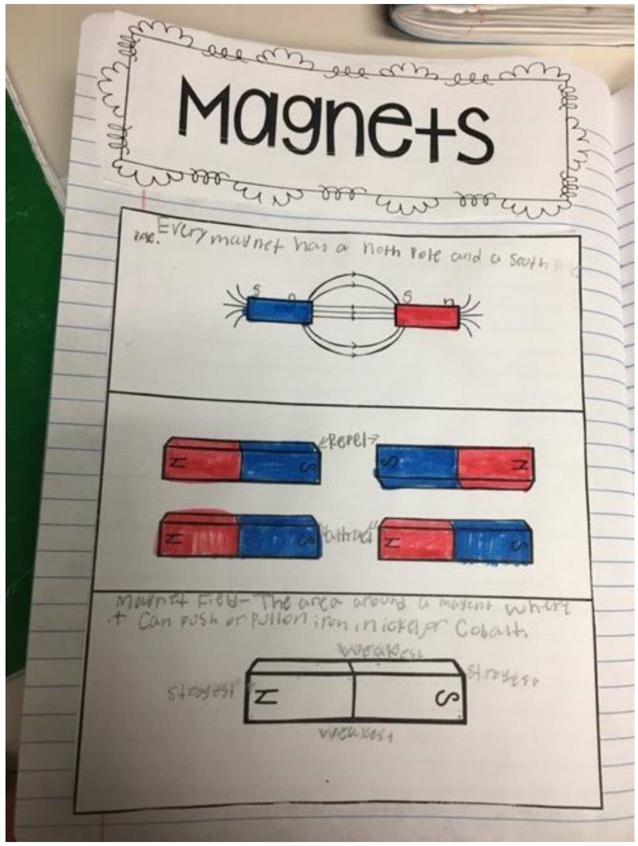

Figure 1. Foldables example in a student's notebook

When asked about the purpose of using foldables during guided notes, Ms. Reed explained that they helped students learn key scientific vocabulary and made it easier for students to take in information by breaking it down:

> Vocabulary is definitely the majority of what is involved in a foldable. I think things like matching concepts, writing notes, is usually what I use most of my foldables for. And, I think that is something that usually it just breaks up the information in their brain so that instead of taking a notebook page and knowing that they're gonna have to fill it in with all this information, it's more like oh, I'm gonna use this circle to write it in. It motivates them a little bit more because they're not overwhelmed by the format of it. So, if you're gonna talk about flowers and you put it inside of a flower shape, fourth graders will be a lot more inclined to write down information about the flower.

Representative example of guided notes. The excerpt below shows teacher-student interaction while the students were asked to take notes about how electrons passing through the filament makes a bulb light up.

Excerpt 4.6

Ms. Reed: Alright, this next section also has a few sentences of notes that we need to write. Ok, try to write pretty small so that you can fit them. You are only writing about two and a half sentences for this one. (read) A bulb has a filament inside. (Marking something in the PowerPoint slide projected on the screen) This is the load. This is whatever it is we are powering, right? Whatever it is we are gonna turn on and off. So, it doesn't have to be a light bulb. It could be a sound. It could be a movement of something. But for a light bulb in particular, when we are talking about electricity, this is what usually comes to mind, right?

Unknown student: Yes.

Ms. Reed: (read the text on the PowerPoint slide) A bulb has a filament inside. The filament wire is very thin, so electrons have a hard time passing through. I definitely would like you to write that. (continued to read the next sentence) And when electrons do pass through the filament becomes hot and begins to glow. Yeah all of this is important. (short pause) If electrons were not passing through this filament, would it get hot?

Students: No.

Ms. Reed: No. So would it glow?

Students: No.

Ms. Reed: No.

(Students started writing.)

(Classroom transcript, 3.28.19)

In this interaction, Ms. Reed was holding the floor by giving students instructions for notetaking, lecturing on the scientific concept of load, and reading the text on the projector screen for students to copy down. She reinforced her requirement for students to copy the sentences she just read by stressing their importance (i.e., "Yeah all of this is important."), but she didn't offer a reason why. After reading the sentences, Ms. Reed initiated two I-R-E sequences by asking the questions "If electrons were not passing through this filament, would it get hot?" and "So would it glow?" Both questions received students' disconfirmation. According to Bloome, Puro, and Theodorou (1989), both the prosody and the form of such questions prompt the answer, assisting students in displaying appropriate lesson behavior (e.g., responding to teacher questions during I-R-E) rather than substantive engagement with the subject knowledge. Throughout this interaction, the students engaged passively by listening, responding to teacher questions, and copying information deemed important by the teacher.

Occasionally, while the rest of the class were writing in their notebooks, some of the most responsive students in Ms. Reed's classroom asked questions related to the science topic they were taking notes about. Ms. Reed would briefly address their questions before moving on to the next sentence(s) she would like the students to write down. For example, below, the excerpt from the classroom video log shows the interaction between Kevin and Ms. Reed, which happened right after the whole-group interaction in the transcript above. Kevin was asking about proton power out of curiosity.

> Excerpt 4.7
> Kevin asked Ms. Reed, "How about protons? Do wire flow protons?" Ms. Reed said no and that electricity is powered by electrons. Kevin then continued to speak (inaudible). Ms. Reed responded, "Some proton power? That would be nice if we could figure that out, if we could have two kinds of power. It would be pretty cool." "One power powers like house XXX" Kevin spoke about his idea. Ms. Reed then praised him, saying, "Cool. That's interesting. That's a good idea for an invention."
>
> (Classroom video log, 3.28.19)

Celebrated practices. The following practices were the norms for participating in guided notes:

- Facing the teacher
- Holding the pencil
- Keeping hands still

- Writing/copying notes
- Listening
- Putting pencils down when finishing writing
- Being patient and not distractive when finishing writing

Ms. Reed reinforced these norms by stating her expectations before and during guided notes. Below, the transcripts show how Ms. Reed regulated students' behaviors during guided notes.

Excerpt 4.8
Before a guided notes session started:
Ms. Reed: During guided notes today, my expectation of you is to be an active listener. Active listeners face their speaker. (Ms. Reed waited for students to go back to their seats) Your hands, unless you're writing, are not messing with anything else right now. Your feet should be still, unless XXX You should have a pencil in your hand right now. (Ms. Reed looked towards Felipe's direction, waiting to get his attention, then continued to speak when Felipe looked her way) We are working on the foldable that has the picture of a battery on it. And what we are gonna write underneath the battery is this information right here.

(classroom transcript, 3.28.19)

Excerpt 4.9
In the middle of a guided notes session:
Ms. Reed: If you are done, make sure your pencil is pushed down, so that I can see who's not writing still. Would you just wait a few more seconds? Just remember to be patient. (pause) Not everybody writes at the same pace. We're just waiting for a few of us to finish up.

(classroom transcript, 3.21.19)

Marginalized practices. During guided notes, the following practices were marginalized:

- Refusing to write when required to do so
- Having side conversations while writing
- Asking questions about writing instructions

As students were required to follow Ms. Reed's instructions for taking notes closely, any practices by students that might signal their lack of engagement usually received Ms. Reed's reprimand. For example, during a lesson on electromagnet, when Ms. Reed noticed Felipe was lying back in his chair and looking at the board while most of the students nearby were writing in their notebooks, she said, "You should have a pencil right now. You should be writing down what I have written up on the white board. This is your warning, Felipe." In response, Felipe turned towards his table. However, he did not start writing immediately but rubbed his notebook page.

Also, side conversations indicated being off task when students were supposed to be writing. When Ms. Reed noted student conversations, she either asked the students not to talk if they were not done with writing or gave them a reminder that only side conversations involving peer help were acceptable (i.e., "Hope those side conversations are just people helping each other to finish."). Finally, asking questions about writing instructions which had been given by the teacher sometimes led to receiving criticism. Below, the excerpt shows Ms. Reed held Callie and Pearl accountable for not listening. Before this interaction happened, Ms. Reed instructed the whole class to write the word "strongest" near the poles of a magnet illustrated in their foldables and the word "weakest" in the middle of the magnet. After Ms. Reed repeated the instructions for Callie, Ms. Reed refused to repeat them to Pearl for another time.

Excerpt 4.10

Callie: Where do we write that?

Ms. Reed: Callie, if you are listening when I gave these instructions you'll never get this far behind at the end of this slide. On your bottom photo, where you have one thing, just the one magnet, right? Red side, blue side. You need to write the definition for magnetic field above it and then you are gonna show me where the magnetic field is the strongest on the photo.

That's what this is (pointed to a picture of magnet on the projector screen) indicating, Ok? So you need to write the word ‘strongest’ on the ends of it and in the middle of the magnet is where you’re gonna write the weakest.

Pearl: Are we writing that starred thing inside the box?

Ms. Reed: Pearl, I’m not gonna repeat these instructions a fifth time to you.

(classroom video transcript, 3.29.19)

Jeopardy

Overview of Jeopardy. Jeopardy was a quiz that Ms. Reed held before an end-of-unit test to help students review the knowledge learned in a unit. It involved different table groups competing to gain more points by giving the right answer to the teacher’s questions. There were thirty-one events that included student-to-student or student-to-teacher interactions during Jeopardy. During my observation, the teacher only held one Jeopardy quiz for the plant and animal structure unit due to time limit. Jeopardy involved the following actions by the teacher and students: 1) the teacher nominated a student to pick a category (e.g., animal adaptations) and a number of points to be gained (e.g., 500); 2) the teacher read and showed a quiz question on the projector screen based on the chosen category and points; 3) students shared their answers within their table groups and each group member wrote his or her answer on a mini white board; 4) students showed their answers to Ms. Reed at the end of countdown; 5) Ms. Reed announced the right answer and decided which answers from the students to take or not to take; 6) Ms. Reed announced the points each group were going to get for the question. When students shared their answers within table groups, they spoke almost in a whisper to prevent giving away their answer to a neighboring group. And some students covered their white boards immediately after writing down their answer. Sometimes, the teacher checked with students at a table group to see if they had the right answer before checking with the whole class.

Representative examples of Jeopardy. I will show here examples of both teacher-student interactions and table group interactions during Jeopardy. The example below illustrates how Ms. Reed checked students' answers at Lucas's table after she announced the question "What function does migrating from one place to another serve for animals?" Their conversation generally followed the I-R-E pattern.

Excerpt 4.11

Ms. Reed: So what is migrating?
Callie: Going to a place or another (rising intonation). Going to one place or another.
Ms. Reed: That's not it. Migrating.
Callie: One place to another?
Ms. Reed: They go one place to another. So what did we watch about or read about?
Charlie: Shelter in the winter.
Ms. Reed: That's a good one. That's to take shelter. Are you talking about the deep sleep type of shelter? Just to get away?
Charlie: Yeah.
Ms. Reed: Ok, is there any example you guys could think of? Is there something=
Callie: =Polar bear?
Ms. Reed: What'd you hear that day? Did you watch the video about butterfly?
Callie: Yes.
Charlie: Butterfly.
(Ms. Reed affirmed Charlie's answer in a whisper and left their table.)

The next excerpt shows how Ms. Reed read student answers group by group and gave evaluations to each answer. Across different Jeopardy questions, Ms. Reed mostly read only one answer from each table group, and those answers she read had a complete sentence, phrase (e.g., "to get food and water"), or word (e.g., "sea", "ocean").

Excerpt 4.12

Students held up their mini white boards to show Ms. Reed their answers to the question "What function does migrating from one place to another serve for animals?"

Ms. Reed:	To survive and get food. So is it possible that the food might run out in a place XXX they need to go somewhere else?
Unknown student:	Yeah.
Ms. Reed:	Yeah, I'll take this. Good answer.
Ms. Reed:	(moved on to the next group) Like a monarch butterfly flies to Mexico in the winter! To stay WARM in the winter. Very good!
Ms. Reed:	(moved on to another group) Butterfly. An animal migrates to take shelter in winter. Example is the butterfly. Give it to you guys.
Ms. Reed:	(moved on to another group) I'll take it. That's a good one.

During Jeopardy, sharing answers among table group members involved different patterns across different tables. Sometimes, students interacted differently across different Jeopardy questions too. In addition, sharing answers did not necessarily lead to agreement among table group members. The two excerpts below demonstrate how members at Camila's table signaled agreement by: 1) saying the same answer out almost simultaneously; 2) copying down the answer shared by the most competent member on their white boards.

Excerpt 4.13
Ms. Reed announced the first question "An animal that is warm-blooded, has live babies, and fur is classified as what?". "Mammal." Camila, Abi, and Sophie whispered to each other. They then started writing. "Good job, Camila!" Sophie said to her. Sophie and Abi each gave Camila a high five.

Excerpt 4.14
Ms. Reed announced the Jeopardy question "Write one organism, another living thing, and one non-living thing that can be found in a desert.". As the students were writing on their white boards, she checked their answers table by table. When she approached Sophie's group, Sophie told her a snake was an organism. Ms. Reed then asked if her group members agreed with her. Without showing agreement verbally, the group "copied" snake to their boards. Camila asked for Sophie's help and copied the word 'snake' to her board.

Sometimes table members had different answers to a Jeopardy question. It was observed that a proposed answer could be ignored by a more dominant member who constantly took on the leader role at a table. Also, table members corrected one another's answer when they found what he or she wrote on the white board was not the correct answer. The two examples below illustrate such situations.

Excerpt 4.15
Ms. Reed announced the Jeopardy question "Describe two animal structures that allow animals to breath oxygen."
Audrey: (whispered to Jay) Mouth and nose. (Then started writing)
Jay: (stood up, moved closer to Felipe, and whispered) Mouth XXX
Audrey: XXX
Jay: (to Audrey) What?
(Ms. Reed talked to Felipe briefly to see if he knew the answer.)
Jay: (sat down) XXX
(Jay were writing on their mini white boards. Felipe slowly started writing and then stopped after he wrote down just one letter. The camera couldn't catch what he wrote. Based on the movement of his hand, what he had written down seemed to be the "L" letter, rather than complete words.)
Audrey: It's mouth and nose.
Felipe: (to Audrey) No, it's lung.
Audrey: (no verbal response, ignored Felipe and waved to the camera)

Excerpt 4.16
Ms. Reed announced the Jeopardy question "Why do plants need to have bright flowers?"
"To look different." Lucas suggested to Callie. "To attract animals." Callie said as she wrote on her board. The group members were writing on their boards. Callie and Lucas showed their group members what they wrote. Callie's board wrote, "so they can attract animals". Lucas seemed to negotiate his answer with his group members, but their conversation was hard to hear. Finally, Colin stood up to wipe off Lucas' answer from his board and wrote the group's answer on Lucas' board.

Celebrated practices. The practice of writing down the right answer was publicly celebrated by the teacher during Jeopardy (e.g., "I'll take this. Good answer."). When the teacher checked student answers as they were writing them down, telling the right answer verbally received the teacher's affirmation too.

Marginalized practices. The practices of peeking at/eavesdropping on another group's answer and doodling on the white board were marginalized during the Jeopardy quiz. It was frequently observed that students blamed members from a neighboring group for 'stealing' their answers. In the examples below, students held their peers accountable for "eavesdropping" and "cheating".

> Excerpt 4.17
> (Lucas, Martin, Colin, and Callie were at the same table.)
> Ms. Reed asked the question "what is the name of the bird in the game we played about animal needs?" to the whole class. "That's easy!" Lucas said, and started to write on his board. "Eavesdropping!" Martin warned James' group who sat next to them.

> Excerpt 4.18
> (Sophie, Camila, Abi, and Julie were at the same table.)
> A T/F question was announced. Camila's group members whispered "it's true" to each other. Sophie warned her group members, "Lucas just heard us." She stared at Lucas' group in a cautious and dissatisfied manner. A moment later, Ms. Reed declared that all groups got the right answer. "You need to stop hearing us, because it doesn't count." Camila warned Lucas' group.

Doodling on the mini white board was another marginalized practice during Jeopardy. For example, when Ms. Reed noticed Justin doodling on his white board instead of writing down an answer, she warned him, "If you are gonna be wasting time, then you won't be playing the game."

Table Group Discussion

Overview of table group discussion. Table group discussion refers to activities in which table group members discussed questions assigned by the teacher. The duration of such discussions ranged from twenty seconds to ten minutes. These discussions had two purposes: one was for students to share ideas (e.g., Ms. Reed once asked the students to share at their tables thoughts on how to know how old something is), and the other was for the table group to collectively determine their answer to a question. There were only five events of table group discussion identified in classroom video data. This scarcity resulted partly from the infrequency of table group discussion in regular lessons that were mostly focused on lecture and the whole-group I-R-E procedure. It also resulted from the short duration of table group discussion. As most table group discussion lasted from twenty seconds to one minute, I did not have a chance to move the camera and the microphone near a student table before the discussion time ended. In addition, I estimated that putting the microphone on a student table seemed abrupt and somewhat interruptive from the students' perspective. The five events I documented occurred exclusively at two case study students' table groups (i.e., Camila's and Felipe's).

Representative example of table group discussion. Table group discussions were characterized by table group members taking turns to share ideas. At Camila's table, discussions were often led by Sophie and Pearl. In the following excerpt, Camila's table members were collectively determining whether the question "How does the temperature of the room affect how quickly mold grows?" was testable. While Sophie and Pearl actively shared their ideas and orchestrated the discussion, Camila and Kelly mostly listened. Camila's short utterances (e.g., "Yeah." "Feasible.") indicated only listenership and agreement. Kobe, the only male student at the table, didn't participated the conversation at all.

Excerpt 4.19

Sophie:	XXX I think it's a why question OR it's a yes/no question.
Pearl:	It's (short pause) No, it is testable because it is not one of those questions. If it is testable then you can test it.
Sophie:	Yeah we could test it cuz we can do how much the room right?
Pearl:	We can change the temperature of the room.
Camila:	Yeah (nodded)

Sophie: Yeah. And it's... what is it called, the money thing?
Camila: Money.
(Both Camila and Kelly looked towards Pearl.)
Pearl: Feasible?
Camila: (low voice) Feasible.
Sophie: Yeah.
Pearl: It's feasible.
Sophie: So I'ma (started writing) / Yeah.
Camila: So it's testable (took a brief look at Pearl and Pearl's worksheet, then prepared to write).
Sophie: So we could just write it's testable and it's feasible. Testable and feasible.
(Group members started writing on their worksheets. In the conversation so far, Kobe wasn't participating at all. He played with something in his hand.)

Celebrated practices. When the purpose for a table group discussion was to collectively decide the answers to the questions in a worksheet, the celebrated practice was writing down the correct answer. For example, when Ms. Reed approached Camila's table during their discussion on the testability of some listed questions, she checked and praised Camila's written answers in her worksheet by saying, "Excellent work you guys. Excellent work." When the purpose for a table group discussion was to share thoughts about an assigned question, the celebrated practice was demonstrating one's knowledge of science facts. On one occasion, Ms. Reed approached Camila's table to ask about their ideas on how to know the age of something while they were sharing thoughts within the group. Pearl suggested dirt or rock, and Sophie and Kelly suggested trees. Ms. Reed then approved answers from both students.

Marginalized practices. There was no marginalized practice identified for table group discussion.

Independent Work

Overview of independent work. In Ms. Reed's classroom, the procedure of independent work involved students working on assigned tasks on their own by following the instructions given by the teacher and/or receiving individual support on an assigned task from the teacher or a peer. There were eleven instances of independent work identified, which all occurred during the science fair project unit. During independent work time, students were required to conduct background research, do experiments, record data, take pictures of their experiment process, complete PowerPoint slides, or design display boards for their own projects. Students predominantly asked for Ms. Reed's help with their research questions, locating source information on a webpage, the identification of variables in their experiments, the feasibility of their experiments, the handling of experimental materials, and so forth. The help that the students provided for their peers included locating source information a webpage, taking pictures of the experiment process, spelling, and completing the PowerPoint slides for presentation. The teacher monitored students' behaviors and task progress during independent work. While working towards the completion of their science fair projects, students were observed to move at different paces and to engage in different tasks in contrast to each other during the same independent work period.

Representative examples of independent work. I will show below several examples of how students engaged in independent work. As they were taking on assigned tasks independently, they also sought the teacher's and peers' help, provided help for another table group member, and were attracted by other students' experiment. The first three examples illustrated students' request for the teacher's help and how Ms. Reed addressed students' questions by providing answers directly, making suggestions, validating or disproving students' attempts at a task, and explaining important scientific terms (e.g., dependent variables).

Excerpt 4.20
Locating source information (i.e., copyright date):

Sophie: (showed Ms. Reed a website she found) Is this the due date cuz it says "2019 national DNA"?
Ms. Reed: So that's not the publishing date. That is the title of the things though. But it looks like/ if we go down a little bit (scrolled down the webpage). U::m, It does say that these are from archives. You can use 2009 / Oh wait. Right here. April 2009.
Sophie: Oh Ok. Thank you.

(classroom video transcript, 4.12.19)

Excerpt 4.21
Developing testable questions:

Pearl: (read her questions) XXX
Ms. Reed: Ok, THIS is testable, right? You can measure that. Good, that's what I wanted you to understand, XXX really measure other XXX you were talking about. So good job. (read her next question) What inside a vegetable that makes electricity? That's a good one, but I don't know if we can investigate that with an experiment per se. That's a really good question. And it is testable. (read the third question that Pearl had) Does the mold on a vegetable affect the electricity it makes? Ok, so far in my opinion. This is the best one. But either of these two if you got a, if you feel like I just wanna do it, you have this option. It's my opinion you should go with this one.
Pearl: Ok.

(classroom video transcript, 4.4.19)

Excerpt 4.22
Identifying variables in an experiment:

Ms. Reed: Ok, excellent. What is the part of this question that you are gonna change, that you can control?
Anna: Uh, temperature.
Ms. Reed: Temperature. So which one of the variables XXX that?
Anna: Uh, [the amount of mold].
Ms. Reed: That's it. Write that down.
Anna: XXX

Ms. Reed:	That's right. So then you need to-, do you have your worksheet for the variables still? The loose worksheet, cuz that might help you out.
Anna:	(looking for the worksheet in her folder)
Ms. Reed:	It's right here (pulling it out). Ok, (read) the dependent variables are what the scientist measures in the experiment. So we are talking about how temperature affects mold growing on bread. What are we gonna measure in our experiment everytime we look at the bread?
Anna:	Mold?
Ms. Reed:	The mold. The amount of mold right? So specifically, I need you to say the amount of mold (pointed to her science fair planning packet) for your dependent variable.

(classroom video transcript, 4.22.19)

Peer help between table group members was another practice that students often engaged in during independent work. The interaction below shows Camila helped Sophie take a picture of her pouring a blue liquid into a spoon as evidence of doing her strawberry DNA experiment.

Excerpt 4.23
Sophie: Can someone take a picture for me?
Camila: I can do it.
Sophie: Can you hold that camera and just one picture=
Camila: =Like this?
Sophie: Me pouring it as evidence?
(Camila held up Sophie’s phone. Inaudible talk.)
Camila: I’ll take a picture of you pouring this.

(Classroom video transcript, 4.25.19)

Finally, students were often observed to watch another student doing his or her experiment during independent work. When students passed by a peer who was doing his/her experiment, they would ask what she/he was doing out of curiosity and leave a brief comment (e.g., “That’s working? That’s cool.”). Sometimes, the students got easily attracted by their table group members’ experiments and distracted from their own tasks. The next two excerpts show examples of students from the same table group becoming curious about another's experiment.

Excerpt 4.24
Pearl brought out her potato clock kit, lemons, limes and potatoes. She was about to start her experiment to test out if the citrus and potatoes could power a clock.
Pearl: (asking Kelly) What should I start with? The citrus or the potato?
Kelly: Potato.
Pearl: Ok. (Taking her potato out of the container)
(A moment later.)
Pearl: (to Kelly) Should I start with small potatoes or big potatoes?
Camila: Small.
Kelly: Small.

(Classroom video transcript, 4.25.19)

Excerpt 4.25
Jennie came back to the table with her cup of water. Jennie was the only one who started her experiment at the table. "I'll put it in here." Jennie said, as she put a rock candy into a cup of water. All of her table group members were immediately drawn by her experiment.
Felipe: You know, it's gonna melt, you know.
Jay: Which one is hot? Which one is cold?
Jennie: This is hot XXX
Jay: XXX
(Felipe and Jennie watched as Jennie stirred the rock candy in the water slowly.)
Jennie: It makes the water so XXX
Jay: Can I change the water please?
Jennie: Oh my god (looking at her candy in the water).
Jay: It's now-, the water is now blue::.
Jennie: It made it blue (smiled).
Callie: Wo::w.

(Classroom video transcript, 4.25.19)

Celebrated practices. The practices of completing a task independently and using time on the assigned task were sometimes stressed in the teacher's announcement of her expectations for students before an independent work period began. However, not every task required the students to complete it alone. In the example below, Ms. Reed expected students to only ask for help from a peer nearby and to not completely rely on others when completing the task of locating source information (e.g., publication date, author).

> Excerpt 4.26
> Ms. Reed: If you are wondering, if you decide, ok, maybe I need an extra set of eyes, you can have one of your friends maybe turn your computer towards them to have a look. That does not mean you are getting up and going across the room to somebody to have them look at your computer to find something for you. And (stressed) that does not mean that anybody is doing any work for you. I'm saying if you tried it and you can't find it, you may ask one person to look one time.
> (Classroom video transcript, 4.12.19)

Following the teacher's task instructions was celebrated through the teacher's praise. Below, Ms. Reed publicly praised Anna for filling out source information in her background research worksheet.

> Excerpt 4.27
> Ms. Reed: (to the class) I can see that Anna has at least one reliable source because she has finally finished filling in her source 1 author and all of that good stuff. I encourage you at this point if you've just been reading the website, first of all, if you decided to click on it because it's a .gov, .edu, or .com, then you probably decided it was reliable. So you need to start writing down the information about that source.
> (Classroom video transcript, 4.12.19)

Marginalized practices. The following practices were marginalized through either the teacher's discipline practice or peer criticism during independent work:

- Playing with experiment materials
- Moving around the classroom
- Watching others doing their experiment rather than doing the assigned tasks
- Making noise and disturbing others
- Asking the teacher to repeat her instructions halfway through independent work
- Asking questions irrelevant to task completion

The practices of playing with experiment materials, moving around the classroom, and watching others doing their experiment were often perceived as being off task by Ms. Reed. The following excerpts from classroom video logs showed Ms. Reed responded to these student practices by giving a reminder or a rebuke.

> Excerpt 4.28
> Lucas finished taking pictures of his bouncy egg. "Ok, I'm done." He said. And this was heard by Ms. Reed, who stood at her podium recording individual student's progress. "You're done with your slides?" Ms. Reed asked Lucas. As Lucas was showing another student his bouncy egg and then placing it back to the cup, she reminded him, "making sure we are not playing around, Lucas."
>
> (classroom video log, 4.30.19)

> Excerpt 4.29
> The classroom became noisy when students were supposed to continue doing background research and recording source information in their science fair planning packet. Kevin, who left his desk, was talking to Jay and Callie. Ms. Reed reminded the class, "So if you are out of your seat right now. You should have a really good explanation."
>
> (classroom video log, 4.22.19)

> Excerpt 4.30
> A lot of the kids were in the backyard surrounding Jay, who laid a bottle of coke and several empty plastic cups on the ground and was about to start his coke mentos experiment.

Ms. Reed:	You are not welcome to be outside, unless you are out here because you are finished, then you should not be outside. Anna, you are not finished. Joseph, get inside. Boys, I don't think you guys are finished. Let's go. The only person that needs to be watching right now is Jay and anyone who's actually finished, so Alex can stay. Martin, are you done?"
Martin:	I'm done with that graph.
Ms. Reed:	Do you have work in my class that you can be doing?
Martin:	(thought for a moment, then walked towards the entrance of the classroom)
Ms. Reed:	Yeah. I think so. (to other students outside) Do you guys have other things that you could be doing right now? Ok, then get on [with] it. I think Jennie and Audrey, you guys can stay. Ok, (to the students inside the classroom) you need to be working right now, this is your only other experiment day. So I don't think it is wise to waste time.

(Classroom video transcript, 4.26.19)

Sometimes, students showed intolerance if someone at their table made noise to disturb others during independent work. Chastisement from female group members at Felipe's table was often observed when they found Felipe to be causing disturbance. An example was shown below.

Excerpt 4.31

Felipe clicked the mouse for several times and his computer kept pronouncing "porous". Jennie asked him to stop. But Felipe clicked his mouse two more times, which led both Callie and Jennie to tell him to stop. "No," Felipe said to Jennie. "Stop." Jennie said again. Felipe continued to make his computer pronounce "porous". Jennie told Felipe stop for the third time.

Felipe:	It's just a word (smiling).
Jennie:	You are trying it too much. If you wanna stay XXX in here, put some effort on.
Felipe:	(hit his mouse hard)
Callie:	Haha, didn't work.
Felipe:	(clicked his mouse several times)
Abi:	Stop, plea::se.
Jennie:	Felipe, sto::p!
Felipe:	I'm trying to learn.
Jennie:	XXX
Felipe:	It's just porous. (kept letting the computer pronounce "porous")
Abi:	(handling Felipe's computer) Stop.

(Classroom video transcript, 4.12.19)

Although students usually raised up their hands to signal to the teacher that they needed help, not all their requests or questions received Ms. Reed's immediate assistance. The two examples of teacher-student interactions below illustrated this situation. In the first example, Ms. Reed interpreted Felipe's raised hand as a request for her to repeat and explain her instructions for doing background research online for a potential science fair project. Before giving Felipe further directions to follow, Ms. Reed admonished Felipe for not asking questions earlier about directions when given the chance.

Excerpt 4.32

Ms. Reed:	Hang on a second, (walking to Felipe) What? I explained all of the directions several times and I had people raised their hands if they didn't understand, Felipe, did you raise your hand when I ask that question?
Felipe:	[I didn't]
Ms. Reed:	Why?
Felipe:	(looked at Ms. Reed)
Ms. Reed:	So you did not ask me for help when I gave the instructions. So why would I come over here and give you all of the exact same instructions that I just repeated out there?
Felipe:	(looked downhearted, eyes looked down)
Ms. Reed:	Open your packet to the page everybody else around you was on. Right now.
…	
Ms. Reed:	Ok, you need to sign in your Chromebook and you need to get on Google. You are looking at these questions right here. You are trying to think of questions that will help you to figure out what your experiment is gonna look like. So maybe you need to google the whole experiment. (opened his Chromebook screen) I'm not gonna do the work for you. Look at me. You have to try right now. You have to put in some effort. Sign in.

(Classroom video transcript, 4.12.19)

In the second example, Ms. Reed refused to address Kevin's questions not related to completing the task of taking down source information once he determined that a website was reliable. She disapproved Kevin's question about how magnet a works that might have emerged while he was doing background research (i.e., "You don't need to understand how magnets work.", "That doesn't mean you need to explain magnets.").

Excerpt 4.33

Ms. Reed:	You don't need to understand how magnets work. That's about it. You were trying to show me in a basic (stressed) experiment whether or not friction influences magnet. That doesn't mean you need to explain magnet. That does not mean that you need to have a train. You are asking the question that you were asking. There's only one testable question. (read his packet) That question is how materials on the track affect the speed of the train. Magnets don't influence that. What we need to know is does friction influence magnets. And that's a basic concept. Super simple. In 4th grade we can understand it. So this is a reliable website to understand about magnets. Is it or is it not?

Kevin: Yes.
Ms. Reed: Then you need to write down the source information, or you'll end up with nothing to go off of.
…
Ms. Reed: All of these are reliable. It's not whether you-
Kevin: XXX
Ms. Reed: I don't care. I didn't ask you what you want to do, did I? XXX one of the websites and write down facts from that. It's that simple. XXX There's on proof you did anything. Do you understand?
Kevin: Yes.
Ms. Reed: XXX This website, can you read it? (said angrily)
Kevin: Yes.
Ms. Reed: It ends in .org. Does it have an author? Yes, it does. Does it look professional? OK, that's what you need to find. The information you need Kevin is about XXX That's it. You don't need to understand right now. You don't need to understand how magnet works. That's not it. You are trying to show me with an experiment whether or not friction [influences] magnets. That doesn't mean you need to explain magnets. That does not mean you need to have a train. You are asking the question that you are asking... Then you need to write down those source information, or you end up with nothing at all.

(Classroom video transcript, 4.12.19)

Ms. Reed not only repeated the questions that Kevin needed to address regarding the reliability of a source (i.e., “So this is a reliable website to understand about magnets. Is it or is it not?” “Does it look professional?”), but also answered one of these questions herself (i.e., “Does it have an author? Yes, it does.”), indicating the information Kevin needed to take down in his packet was pretty obvious and that the task shouldn’t be very hard for Kevin to complete. This excerpt indicates that asking questions irrelevant to the fulfillment of a task was sometimes marginalized and even devalued in Ms. Reed’s classroom, even if the questions could be closely related to the science subject.

Research Question 2: Science-related Identities That Case Study Students Developed Through Classroom Interactions

This section explores the science-related identities of focal ELLs over the two-month period of observation. I will shed light on the social positioning that happened for Camila, Felipe, and Lucas across various science learning contexts in Ms. Reed's classroom, including whole group I-R-E procedure, jeopardy, table group discussion, independent work, and science fair presentation.

The focal ELLs each had different classroom experiences and identities. The findings are briefly summarized below, and I will address the social positioning of each student in turn.

- Camila had a consistent identity as quiet and agreeable student. And she often positioned herself as needing help with Sophie, who she identified as her friend and a good science student. But her positions as "quiet" and student who needs help also led her to be positioned as less authoritative.
- Lucas's habitual behavior of zoning out during guided notes and avoiding other writing tasks often received the teacher's reprimand and thus led to the ascribed position as uncooperative or unmotivated student. His position as incapable student was evidenced by table member's ignoring of his proposed answers during jeopardy and the teacher's takeover of literacy tasks during individual instruction.
- Felipe was often positioned as uncooperative or resistant student because his classroom behaviors did not meet the teacher's expectations. He was positioned as needing help and incompetent by his table members, but he often contested the

> position as incompetent. His difficulty with language and literacy, the classroom accountability system frequently based on written product as well as the English-only policy shaped his identity as non-writer.

Camila

Camila as quiet, agreeable student. Camila's position as quiet student was evidenced by her lack of presence in the most frequent whole group IRE procedure as well as being less verbal during table group discussions. Ms. Reed described her:

> I think a lot of the time Camila has been pretty quiet and because she is not a behavior challenge, like some other students are, she flies under the radar unnoticed. (Ms. Reed, interview in May 2019)

Camila was placed by Ms. Reed with Pearl and Sophie at the same table. Ms. Reed believed that by such placement, Camila would get language support from the two whom she liked to be with. Ms. Reed also expected there to be polite disagreements and a conversation back and forth between Camila, Pearl and Sophie. The other table group members were Kelly and Kobe, with Kobe being the only male student at the table and identified by Ms. Reed as less competent behaviorally and less motivated academically. During table group discussions, Camila assumed the position as quiet and agreeable student by listening to other table members talk and expressing agreement most of the time. She was never observed to initiate a conversation during table group discussions. When she spoke, her utterance was often short, and she was not very confident or insistent about her own ideas. For example, the event below examines in detail how Camila took on the position of agreeable student as well as how her table group members positioned her when Ms. Reed required table groups to discuss and decide whether the first five practice questions in the "testable questions" worksheet were testable (see Figure 2). Ms. Reed described her expectations regarding this particular table group discussion as follows:

> With your table group, you need to determine, are the questions testable? Not testable? And you need to write one thing as to it is or it is not testable. So if it's a yes/no question, you should know it's not testable. It's a why question, it's not testable. If I wanna know what someone thinks about something, that's an opinion, it's not testable…You have this time to do with your group. Talk to each other, help each other out.


Practice:

1. **How does the temperature of the room affect how quickly mold grows?** Testable / Not testable
Why? ______

2. **When does winter start?** Testable / Not testable
Why? ______

3. **How does the planet that you are on affect how high you can jump?** Testable / Not testable
Why? ______

4. **How does the type of shoe you are wearing affect how fast you can run?** Testable / Not testable
Why? ______

5. **Did students master their last science test?** Testable / Not testable
Why? ______

6. **Which is better, coffee or soda?** Testable / Not testable
Why? ______

7. **How does the type of liquid affect how quickly sugar will dissolve in it?** Testable / Not testable
Why? ______

8. **How does the type of REAL airplane affect how far it can fly?** **Testable** / Not testable
Why? ______

9. **How does the type of PAPER airplane affect how far it can fly?** Testable / Not testable
Why? ______

Complete for Your Project

Now talk with your group about what testable question you would like to do for your project! You may use the list of questions or write your own. Just make sure that it's testable! Write your top three choices in your science fair planning packet.

Figure 2. The testable question worksheet

Sophie initiated their group conversation by expressing her opinion on the testability of the first practice question "How does the temperature of the room affect how quickly mold grows?"

1. Sophie: XXX I think it's a why question OR it's a yes/no question.
2. Pearl: It's (short pause) No, it is testable because it is not one of those questions. If it is testable then you can test it.

3. Sophie: Yeah we could test it cuz we can do how much the room right?
4. Pearl: We can change the temperature of the room.
5. Camila: Yeah (nodded).
6. Sophie: Yeah. And it's... what is it called, the money thing?
7. Camila: Mo(ney)
   (Both Camila and Kelly looked towards Pearl.)
8. Pearl: Feasible?
9. Camila: (low voice) Feasible.
10. Sophie: Yeah.
11. Pearl: It's feasible.
12. Sophie: So I'ma (started writing) / Yeah.
13. Camila: So it's testable (brief look at Pearl and Pearl's worksheet, then prepared to write).
14. Sophie: So we could just write it's testable and it's feasible. Testable and feasible.
    (Group members started writing on their worksheets. In the conversation so far, Kobe wasn't participating at all. He played with something in his hand.)
15. Sophie: (2) Wait! No wait! That's not right testable because (interrupted by Kobe)
16. Kobe: (sounded irritated, sat up a little bit) Oh my god! You don't have to change it. (Making no eye contact with anyone, erasing his writing)
17. Sophie: So let's write (3) can afford (speaking while writing, said slowly and clearly, in a fashion that a teacher gave a dictation), can be fee-a-ble, fee-feeble.
    (Meanwhile, Kobe touched the microphone. Camila hit his hand with her pencil, looking towards Kobe to give him a warning.)
18. Kobe: Did you hit it?
19. Camila: I did not!
20. Kobe: (looked at Sophie's worksheet very briefly) I'm gonna write whatever I want. (wrote while saying) It is feasible.
    (Sophie and Kelly were writing. Camila looked at Kelly's answer and then continued writing.)

Throughout the excerpt above, both Sophie and Pearl positioned themselves as key discussion participants by actively expressing their own ideas and responding to each other's opinions (lines 1-4, 6, 8, 10, 11). Sophie also assumed the position as discussion leader by announcing the finalized answer slowly and clearly and directing the table members to write or not to write (line 14, 15, 17). After Sophie proposed in the beginning that the first question was a why or a yes/no question, Pearl immediately and firmly disagreed and explained why the question was testable by referring to the standards that the teacher required them to use (i.e., because it is not one of those questions). And she further positioned herself as authoritative by explaining what the term "testable" meant (i.e., If it is testable then you can test it.). When Pearl complemented Sophie's statement that they could change the temperature of the room, Camila participated the conversation by saying "Yeah" to express her agreement, affirming Pearl's leadership (line 5). She later repeated particular words (line 7, 9) from Sophie's and Pearl's utterances (line 6, 8) to signal her listenership, continually positioning Sophie and Pearl as discussion leaders. When Sophie asked what the newly taught word about money was, both Camila and Kelly looked towards Pearl, indicating that they expected Pearl to tell the word, thus, positioning themselves as marginal discussion participants. In line 13, Camila confirmed the answer with Pearl and Sophie, positioning herself as agreeable, as Sophie signaled in line 12 the group had reached a conclusion and that she was about to write the answer. While the group members were writing, Camila rebuked Kobe for touching the microphone placed in the middle of their table, and thus took on the position of behavioral monitor briefly.

As the group was discussing the second question (i.e., When does winter start?), the conversation continued to carry on mainly between Pearl and Sophie. When they had difficulty reaching to an agreement on why the second question was non-testable (lines 21-30), Sophie involved both Kelly and Sophie in the conversation.

21. Pearl: Everybody knows the second one is when does winter start. Everybody knows when the winter starts.
22. Sophie: It's / Yeah. It's not testable. Cuz it's a yes/no question or opinion. (While Sophie and Pearl were talking, Camila and Kelly were writing. Again, Camila took a look at what Kelly wrote.)

23. Pearl: Everybody knows when does winter start.
24. Sophie: So that means it has to be…
25. Pearl: Not testable, cuz everybody knows when it starts.
26. Sophie: Yeah. So I think it'll be a yes/no question. It either starts or it either doesn't start. What do you think Pearl?
27. Pearl: (1) Well (2) Cuz everybody know when it starts, so-
28. Sophie: But like for the why?
29. Pearl: (3) (stayed silent. looking down, making no eye contact with Sophie)
30. Pearl: I agree with you for a non-testable question, but I'm talking why.
31. Camila: (just stopped writing, seemed ready to move on to the winter question) (read the question) When does winter start?
32. Sophie: What do you think, Kelly?
33. Kelly: I think it's a yes and no.
34. Sophie: Yes and no. How about you Camila?
35. Camila: Um=
36. Kobe: (Body position towards Sophie) An yes and no. Well she's writing that.
    (Female group members all ignored Kobe.)
37. Pearl: =Well sometimes it'll be an opinion, because people say it starts earlier or it starts late.
38. Camila: Yeah, it's opinion.
39. Sophie: Oh Ok, so it's my opinion.
40. Kelly: Yeah (started writing).
41. Sophie: Because it's an opinion.
42. Pearl: Because it's an opinion (started writing).
    (Camila started writing too after she took a brief look what Kelly was writing.)

Regarding why the question was non-testable, Pearl reiterated that everybody knows when winter starts, whereas Sophie insisted that the second question was a yes/no question. While Pearl and Sophie were negotiating their answers, Camila focused on writing down the answer to the first practice question and did not seek to participate in the conversation until line 31. In line 31, by merely reading aloud the question halfway through the conversation, she did not hold herself accountable for sharing her thoughts and thus positioned herself as a marginal discussion participant. When Sophie invited Camila to share what she thought (line 34), her response showed hesitation (line 35). Camila was also immediately deprived of her right to speak, as Pearl claimed the floor through latched turns, stating that the second question was an opinion and backing up her statement with a reason (line 37). Pearl's idea quickly received Camila's agreement (line 38), which signaled Camila positioned herself as agreeable. Sophie and Kelly also agreed to Pearl's idea. As Sophie and Pearl finalized the answer (lines 41, 42) and started writing, Camila followed them to write and confirmed the answer by looking at Kelly's writing (Kelly was sitting next to Camila). Meanwhile, Kobe positioned himself as outsider/non-participant by choosing to not respond to the female table members and to only copy down Sophie's answer (i.e., "An yes and no. Well she's writing that."). Also, the female table members positioned Kobe as outsider too by ignoring him.

Camila continued to position herself as agreeable while her group was addressing the third question (i.e., How does the planet that you are on affect how high you can jump?). Though she attempted to share her thoughts (see below, lines 47, 55), her utterances were short, and her rising intonation signaled unsureness. In line 57, Camila's idea that the third question was a why question, was quickly dismissed by Pearl, whose answer was adopted as the group answer. Thus, Camila was positioned as unauthoritative. And instead of defending her own idea, Camila accepted Pearl's answer and wrote it down, signaling her identity as agreeable student.

43. Sophie: Ok, for No. 3, how does the planet that you are on affect how high you can jump?
44. Pearl: That is not testable because we can't just fly a=
45. Sophie: =Because it's gravity.
46. Pearl: Spaceship to another planet and go over there and test it.
47. Camila: You should get/ And no? (Rising intonation, looking for Pearl's confirmation)
48. Kelly: (looked at Pearl)
49. Pearl: Well we can't do that for we are talking about science fair=
50. Sophie: =And it's too much money to get a spaceship=

(Kelly nodded. Camila watched Pearl and Sophie talk.)

51. Pearl: =Yeah we can't afford Ferrari, we can't afford a spaceship.
52. Sophie: Ok, So it's not testable.
53. Camila: It's not testable.
54. Sophie: A Ferrari (laughed). Ok, so I think that um (1) let's see…
55. Camila: (looked at Sophie) A why question.
56. Sophie: Yeah a why question. (Camila nodded) Or a yes/no question. (1) What do you think?
57. Pearl: It's a yes/no question.
58. Sophie: Yeah. Ok, let's write it is a yes/no question.
    (All group members started writing down the answer, including Kobe, who wasn't participating in the table group conversation verbally.)
59. Kobe: For number 3?
60. Pearl: Number 3 is a yes/no question.

As the group discussion went on, Camila oriented herself to writing down the group answer rather than taking part in the conversation or sharing her opinions. Ms. Reed's comment on the group work also staged the context that students were accountable for getting the right answer. That is, while Ms. Reed approached Camila's table during their discussion, she checked Camila's written answers and commented, "Excellent work you guys. Excellent work." As Sophie and Pearl proceeded with their discussion on the fourth and fifth practice question, Camila focused on writing down the group answers and shifted to the position as student who needs help by asking to copy Sophie's answers repeatedly (see below, lines 89, 92, 94, 96).

89. Camila: (to Sophie) Can I copy yours?
90. Sophie: (to Pearl) That's-
91. Pearl: That's not testable because you don't know what poor people got and you don't know if they all got it correct.
92. Camila: (to Sophie) Can I copy?
    (Sophie neglected Camila because she was listening to Pearl)
93. Sophie: (to Pearl) Yeah.
94. Camila: (overlapped with Pearl's utterance) Sophie, can I copy yours real quick?
95. Sophie: Huh?
96. Camila: Can I copy yours?
97. Sophie: (nodded to Camila)

(Camila moved Sophie’s worksheet closer to herself to copy her answer(s).)

Later in the group discussion, Sophie also attempted to orchestrate the group conversation, asking them to stop because she had to help Camila (“Guys, hold on. I have to help Camila. Hold on. For number 5, it is a test / yes or no question.”). By offering help and giving Camila the answer, Sophie positioned Camila as student who needs help. In sum, the excerpts shown above illustrated Camila’s marginal participation into the group discussion through her listenership, expression of agreement, and focus on writing the answers. Camila tended to submit to more dominant table members such as Pearl and Sophie. Her short and hesitant articulation showed lack of confidence and was dismissed by Pearl and Sophie. Therefore, Camila was positioned by these discussion leaders as marginal participant interactionally.

Camila as student who needs help. Student who needs help was another position that Camila was frequently observed to take on and to be ascribed. The above table discussion example shows Camila positioned herself as needing help by asking to copy Sophie’s answers. In fact, Camila almost exclusive asked for academic help from Sophie, who she identified as her friend and a good science student. Camila was observed to copy Sophie’s answer or look at what she was writing during jeopardy and when Ms. Reed asked students to independently work on a question. The example below elucidates how Camila positioned herself as needing help with Sophie. She was requesting Sophie’s help with identifying the independent variable in her science fair research question “What location in a school will produce the most bacteria?”

1. Sophie: (to Camila) Ok, what do you need help with?
2. Camila: With my independent (pointed something in her packet) variable, it's location to...

3. Sophie: (read) Locations of bacteria, how fast it spreads. Ok. So write your locations.
4. Camila: Oh so which where does it go to that kind?
5. Sophie: Yeah, your locations.
6. Camila: Ok.
7. Sophie: So like where are you going to do experiment?
8. Camila: Going to the park.
9. Sophie: You can say going to the park. Write down park.
10. Camila: (writing) Park, slide. (took a brief look at Sophie, who was writing) Ok, XXX
11. Sophie: (raised up her head) So park, where else are you going?
12. Camila: My:: (thinking) wait, I'm gonna follow the slide.
13. Sophie: Slide, ok, so put down slide.
14. Camila: (writing) And it XXX
15. Sophie: And then what else?
16. Camila: Uhh:: (thinking) It can be a slide. (thinking) I can try some monkey bars and...
17. Sophie: (tapped Camila's packet) Write down monkey bars. (moved closer to read Camila's packet) S-L-
18. Camila: I put L. (waiting to see what Sophie wrote)
19. Sophie: (wrote down the word "slide" on her packet) S-L-I-D-E.
20. Camila: Monkey bars?
21. Sophie: M-O-
22. Camila: I know how to spell it (writing).
23. Sophie: Yeah.
24. Camila: And I say [how] fast it spreads. (took a brief look at Camila, looking for her approval)
25. Sophie: (nodded) Ok. So you could write how many seconds it spreads once you actually do your ex[periment]. But this is (referring to her own project) after your experiment.
26. Camila: Mine's gonna be=
27. Sophie: Germ.
28. Camila: Mine's, I think-
    (Camila talked to Kobe briefly.)
29. Sophie: Wait, when you're at the park, you have to count how fast it spreads though.
30. Camila: Yeah, but I'm gonna have a swab and gonna have that little-, the testable strip XXX bacteria of different color.
31. Sophie: (nodded, drinking water)

From line 1 to line 23, Sophie positioned herself as teacher by asking Camila what area she needed help with (line 1), confirming Camila's understanding of locations (line 5), asking about her intentions for where to do her experiment (line 7), giving directives for Camila to write (lines 3, 9, 13, 17), and spelling certain words for her (lines 17, 19, 21). Meanwhile, Camila affirmed Sophie's teacher position by answering her questions (lines 2, 8, 12, 16) and following her directives to write down the confirmed locations (lines 10, 14, 18). When Camila mentioned the dependent variable (i.e., how fast bacteria spread) and looked at Sophie to seek her approval or help (line 24), Sophie suggested she record how many seconds the bacteria spreads once she started her experiment and emphasized the time she needed to carry out this step (i.e., But this is after your experiment). As their conversation continued, Sophie seemed to shift to a "dominant teacher" position. While Camila attempted to explain how she was going to carry out her experiment (lines 26, 28), Sophie interrupted her and tried to maintain the floor through latched turns and rushed to an interpretation of what Camila was going to say (line 27). She further signaled authority over Camila, using "have to" to position counting how fast bacteria spreads as an obligation (line 29). In the end of this excerpt, also Camila signaled disagreement ("but I'm gonna…") and explained her experiment plan in detail, Sophie just nodded and did not respond verbally.

Lucas

Lucas as unmotivated and resistant student with respect to writing tasks. Lucas was often not paying attention during guided notes. He was observed to stare off into space, rest his head and one arm on the table, or lie his back in the chair when most of the other students were taking notes as the teacher asked. These behaviors, which indicated Lucas' lack of attention, frequently drew Ms. Reed's attention and were positioned as incompliant or unmotivated by her. When noticing Lucas was not writing in his notebooks as the other students did, Ms. Reed would approach him, asking, "Did you write it?" or reminding him, "Lucas, you should be writing right now." In addition, Lucas was once observed to keeping tying his shoelaces when his table members were discussing whether a website example in the background research worksheet was reliable and writing down answers. Consequently, Ms. Reed admonished him by saying, "Hey, you need to make a decision, Lucas. You may not sit here and do nothing." Again, Lucas was positioned as an unmotivated student in this situation.

Sometimes, Lucas was reprimanded for not following directions for notetaking. The following example happened in the magnets and electricity unit, when Ms. Reed required the students to write down the sentence "Every magnet has a north pole and a south pole." on the foldable with a picture of magnetic poles.

1. Ms. Reed: This is upside down. You haven't done anything that I have asked you to do either.
2. Lucas: I know it's upside down.
3. Ms. Reed: (said furiously) Ok, what are you gonna do about it?
4. Lucas: XXX
5. Ms. Reed: Great, what should you have done in the first place, Lucas?
6. Lucas: Listen.
7. Ms. Reed: Yeah. The second thing you should have done is raise your hand and told me you have a problem right?
8. Lucas: (nodded, without looking at Ms. Reed)
9. Ms. Reed: I don't know who you think I am but I am not a substitute. I'm not somebody you don't know. And you are going to respect me or you're going to leave (handed him a worksheet)

Ms. Reed scolded Lucas for pasting the foldable upside down in the notebook and failing to carry out any of any of her instructions (line 1). Her accusation that "You haven't done anything that I have asked you to do either" positioned Lucas as unmotivated. When Lucas told her he was aware that he pasted the foldable in the wrong direction, she held him accountable for following her directions by asking him how he was going to fix the problem (line 3). In lines 5 and 7, by asking Lucas about the classroom behavioral expectations he should have met, Ms. Reed held Lucas responsible for listening and raising his hand to signal to the teacher when he had a problem. Ultimately, she interpreted Lucas' failure to follow her directions for notetaking as disrespectful and intolerable (line 9), positioning Lucas as resistant student.

Lucas as incapable student. Lucas was also assigned the position of incapable student by his classmates or the teacher across different learning activities in the science classroom. I used the word "incapable" because the way the teacher and the peers acted towards Lucas signaled negative evaluation of his competence in doing something. During Jeopardy, Lucas focused on getting the correct answer and showed a high level of engagement. When he did not know the answer to a particular question, he would ask his table members, "What is it?" and then quickly write down the answer he heard from his table members. He was once even eager to show Ms. Reed his written answer when he had the answer that was very close to the one just announced by her. And by approving his answer (i.e., "I will take it from you guys"), Ms. Reed temporarily positioned Lucas as competent. However, when Lucas suggested an answer to his table members that was later proved to be wrong by the teacher, his table members either ignored his answer or wiped off and corrected his answer on the white board without asking for his permission. These reactions from the table members positioned Lucas as an incompetent student. In addition, Lucas was sometimes accused of stealing an answer from a neighboring group (i.e., "Lucas just heard us.", "You need to stop hearing us, because it doesn't count.") and thus positioned as competitor who cheats. Such a position also positioned Lucas as incompetent, as the students who assigned it assumed that Lucas neither complied with the integrity rule nor did he know the answer.

While Lucas was working on his “bouncy egg” science fair project, he sought help from Ms. Reed and Kevin, who was identified by many classmates as a student who “knows a lot” and uses “big words”. The following example happened after Ms. Reed assigned the independent task of locating and recording source information. To complete the task, the students were supposed to find useful information online that was relevant to the project that they were interested in doing and to locate and write down in their science fair planning packet the author of the source, the title of the article, the title the website, copyright date, date of access, web address, and facts from the source. Lucas asked for Ms. Reed’s help with locating these different items on a website he just found.

11. Ms. Reed: What's up?
12. Lucas: Um so, does it want me like-, as the title does it want me to put like the ww stuff like that or does it want me to put science XXX?
13. Ms. Reed: So the title of the article is the one I told you. The title of the website is the little words right there.
14. Lucas: Oh these?
15. Ms. Reed: Not that. That's your address.
16. Lucas: Oh this?
17. Ms. Reed: You got it right the first time Lucas. It's right here (pointed out the title of the website for him). *The accidental scientist: science of cooking*. That's the title of the website. Ok?
18. Lucas: Oh yeah. (started copying website information in his packet)
19. Lucas: Ms. Reed, so right here (pointed at a blank in his packet) do I put what’s day right now?
20. Ms. Reed: So let's see if it has a copyright date. (reading the website) It does not. I don't see any years. So we're gonna skip that section and you're just gonna go to, (writing) none, Ok? Date of access is today's date, so write today's date.
21. Lucas: Today is twenty-three, right?
22. Ms. Reed: I'll write it for you.
23. Lucas: Twenty-fourth.
24. Ms. Reed: (kept writing) Is it, yeah, 24th, 2019. And the web address is…
25. Lucas: (looked away from the screen and distracted by Anahi's bread for her experiment) The bread smells so good.
26. Ms. Reed: Right here (pointed to the address bar) www.exploratory.edu. So you have to write all of that down. (started writing in Lucas' packet for him)

27. Lucas: (looked away again, said to Anahi) I don't know why but it smells so good. It smells good.

(Anahi closed the packet of her bread. Lucas watched as she did so. When he turned back to Ms. Reed, he noticed Ms. Reed wrote down the source information for him.)

28. Lucas: Oh, I should write, but Ok.
29. Ms. Reed: (responded as she continued with writing) That's fine. I kinda just want you to move on to getting all the info.

In this example, Lucas confirmed with the teacher if he had correctly located the title of the article for multiple times (lines 12, 14, 16), but each time his proposed answer was refuted by Ms. Reed (lines 13, 15, 17). In line 13, Ms. Reed refuted Lucas' answer by repeating her answer that was earlier told to him. She then referred to the article's title as "the little words", which signaled that copying the information or getting the answer was important and that making sense of the text was unnecessary. In line 17, Ms. Reed characterized Lucas' earlier attempt before this excerpt as correct and told Lucas the answer. Ms. Reed's practices of invalidating Lucas' answers and telling the correct answer positioned Lucas as an incompetent student and nonreader. When Lucas sought her help for the copyright date (line 18, 19), Ms. Reed undertook the task of locating the copyright date herself and gave the answer to Lucas again (i.e., "It does not (have a copyright date). I don't see any years."), positioning Lucas as an incompetent student and nonreader again. Furthermore, Lucas was ascribed the identity of non-writer when Ms. Reed wrote down for him more source information (lines 20, 22, 24, 25), although she gave Lucas directives to write (lines 20, 25). When Lucas recognized writing the source information as his obligation (i.e., "I should write."), Ms. Reed legitimized her takeover of the task as a time-saving strategy (i.e., "I kinda just want you to move on to getting all the info.”). However, after Ms. Reed left Lucas did not follow her direction to read the article from the website he found and to record the facts from the article in his packet.

Felipe

Felipe as uncooperative student. During whole-group instruction sessions such as lecture and guided notes, Felipe was often reprimanded by Ms. Reed for not meeting classroom behavioral expectations, which included sitting properly, facing and listening to the teacher, paying attention, writing down notes as directed, etc. As Felipe was placed at a table close to the teacher’s podium, his behaviors during the class were quite visible to the teacher. Whenever he was kneeling on his chair, having side conversations, or not writing notes, these behaviors could easily draw the teacher’s attention. Ms. Reed’s reminders for Felipe to behave properly and her public scolding for Felipe’s failure to meet classroom behavioral expectations positioned him as an uncooperative student, and this uncooperative student identity cemented due to its frequent occurrence. The following examples from the classroom video logs documented how Ms. Reed positioned Felipe as uncooperative and how Felipe reacted to this positioning:

> During lecture in a lesson on static electricity:
> Felipe buried his head in his arms on the table. "Felipe, you need to turn your body towards me." Ms. Reed said, but Felipe was still resting his head on the table. "You need to be looking at me. You need to sit up, please." Ms. Reed continued. Felipe raised up his head from the table.
>
> (video log, 3.21.19)

> Exit ticket:
> Ms. Reed passed out a worksheet to the students that followed along a Bill Nye video. She told students to not stress out if they didn't hear from the video answers to the questions on the sheet. She used this as an exit ticket. "This proves me that instead of sleeping in my class, you watched the video." She told. Both Felipe and Audrey raised their hands up to seek permission to go to the restroom. Ms. Reed told Audrey to go, but she told Felipe, "You need to sit down on your bottom right now. You need to put your name on your paper. And you can wait."

> Felipe started to write on the sheet but he was still kneeling on his chair. "Ok, I'm gonna take a dojo point from you if you can't just relax and follow my expectation." Ms. Reed warned Felipe. Felipe raised up his head looking at Ms. Reed, supporting his head with one hand. "Look at me. Don't do that." Ms. Reed said and then left to her podium.
>
> (video log, 3.22.19)

> Writing down the answer as told by the teacher:
> The class was looking at a website example together to decide whether it was reliable.
>
> Ms. Reed: That's right. That's the reason you're gonna give me. We said in the middle box that .org are sometimes reliable. There's no other reason that we've talked about. So you could write the down. I've given the answer for No. 1. Sometimes it's reliable. And the reason you and I know that is because on the first thing we worked on we put that in the middle box...
>
> Both Lucas and Felipe had been raising up their hand for restroom for some time. Ms. Reed told Felipe to write down the answer, otherwise he couldn't go to the restroom. "Felipe, until I see you this written down, I do not want you to go anywhere." Ms. Reed said. Felipe looked at her, confused and frustrated. Ms. Reed then stressed that she already told him the answer, "XXX been very clear instructions for what to write down right now, if you've been listening right now, you would know what to do. If you don't know what to do, then you need to ask people at your table too." Felipe rubbed his eyes, turned towards his table and looking frustrated. Ms. Reed kept looking at him after he turned. Felipe didn't follow Ms. Reed's instruction to seek help from his group members. Then Ms. Reed said to him, "Look at me. This is how you can tell you're tuning me out. You are not even listening. Pick out a pencil, Ok, question No. 1 asks you is the website reliable. It ends in .ORG (stressed), so what is it?" Felipe stayed silent.
>
> (video log, 4.11.19)

In both the second and the third examples, Felipe's request to go to the restroom was interpreted by the teacher as avoiding the writing task and thus was refused. In the second example, Ms. Reed demanded that Felipe sit down on his bottom and write down his name on the exit ticket. She lowered her expectation by asking Felipe to write down his name instead of the answers to the questions on the sheet. However, Felipe continued to kneel on his chair, which led to Ms. Reed's positioning him as resistant through a warning to take one dojo point from him. In the third example, Felipe showed frustration about Ms. Reed's refusal to let him go to the restroom as well as the task of writing down the given answer. In the beginning, Felipe was criticized by Ms. Reed for not listening to the instructions and required to get help from table members. Then, his practice of remaining silent in response to the teacher's directives on writing down the given answer and asking table members for help was interpreted by Ms. Reed as lack of respect and received her further scolding (i.e., (i.e., "This is how you can tell you're tuning me out. You are not even listening."). As a result, Felipe was positioned as an uncooperative/resistant student throughout this interaction. In fact, Felipe frequently demonstrated frustration and resistance with reading and writing tasks in Ms. Reed's classroom. I will use a separate section to explore his disengagement from literacy tasks and negotiation of a non-writer identity.

Felipe as student who needs help and incapable student. Felipe's position as student who needs help was evidenced by both other positioning and self-positioning in his interactions with the teacher and his table members. Ms. Reed's repetition of task instructions for Felipe alone, checking to see if he understood task instructions, and her offering of individual instruction indexed Felipe's position as student who needs help. While Felipe was sitting at the same table within Jay, Audrey, and Joe, he was observed to ask for and copy down answers from his table members and to be offered help during Jeopardy. The example below showed Jay explained the meaning of the word "advantages" to Felipe when he could not fully understand the Jeopardy question just announced by Ms. Reed.

> Ms. Reed announced the question: Name two advantages that a human has over a snail.
> Felipe: (to Jay) What is that? What is that?

Jay: Advantages is like what do I have over you, like XXX, I'm XXX than you. Like that.
Felipe: (smiled, signaling understanding)

The negotiation of a competent student identity was challenging for Felipe during Jeopardy. The discussion and decision of the group answer to Jeopardy questions took place almost exclusively between Audrey and Jay. When Audrey and Jay reached an agreement on the answer, they would repeat it to Felipe and Joe. Audrey was an active participant during whole-class IRE and achieved an "above standard" score in the state standardized test in science. In the Jeopardy game in which getting the right answer was celebrated and used as evidence of competence, Audrey frequently positioned herself and was positioned as authority/expert among table members. When Felipe shared his answer to a Jeopardy question within his table group, it was often Jay, who sat opposite, that he spoke with. And then Jay would confirm with Audrey if Felipe's proposed answer was correct, therefore positioning Audrey as authoritative and Felipe as lacking authority. I show below two examples of the interactional dynamics at Felipe's table during Jeopardy and how Felipe tried to negotiate a competent student identity. In the first example, Felipe stressed a different but correct answer to Audrey.

Ms. Reed announced a Jeopardy question: Describe two animal structures that allow animals to breath oxygen.
1. Audrey: (whispered to Jay) Mouth and nose. (Then started writing)
2. Jay: (stood up, moved closer to Felipe, and whispered) Mouth XXX
3. Audrey: XXX
4. Jay: (to Audrey) What?
(Ms. Reed walked to Felipe.)
5. Felipe: (to Ms. Reed) XXX
6. Ms. Reed: Anything else?
7. Jay: (whispered to Felipe) Nose.
8. Ms. Reed: Besides their nose, what else?
9. Felipe: Mouth.
10. Ms. Reed: Their mouth. (nodded) Ok. (Left)

11. Jay: (sat down) XXX
(Jay were writing on their mini white boards. Felipe slowly started writing and then stopped after he wrote down just one letter. The camera couldn't catch what he wrote. Based on the movement of his hand, what he had written down seemed to be the "L" letter, rather than complete words.)
12. Audrey: It's mouth and nose.
13. Felipe: (to Audrey) No, it's lung.
14. Ms. Reed: (to class) 5, 4, 3.
15. Audrey: (no verbal response, ignored Felipe and waved to the camera)
16. Ms. Reed: (to class) 2, 1. Show me your white board.
17. Students: (showed Ms. Reed their answers)
18. Felipe: (to his group members) I say lung.
19. Audrey: (gave Felipe a thumb up)
20. Ms. Reed: (read students' answers one by one) Lungs, gills, nose. All correct. Mouth, correct. Gills. Lungs, yes. Gills, lungs, all correct. Nose, mouth. You guys all got it.
21. Students: (cheered)
22. Felipe: I said lungs, you guys said mouth.

In this excerpt, Audrey shared her answer (line 1) with Jay once Ms. Reed announced the question about animal structures for breathing. Jay then immediately repeated her answer "mouth and nose" to Felipe (line 2), positioning Felipe as needing help. When Ms. Reed approached Felipe to check if he knew the answer (lines 6, 8), Jay again offered help without being requested by telling Felipe the word "nose" (line 7). Ms. Reed urged Felipe to say a different animal structure than "nose" (line 8) and then expressed satisfaction with Felipe's answer "mouth" (line 10). After Ms. Reed left their table, Felipe wrote down the letter "L" as his answer, which stood for the word "lung(s)" based on his later interaction with Audrey. When Audrey announced "mouth and nose" as the group answer (line 12), Felipe rejected her answer and insisted the answer was lung (line 13). In response to Audrey's disregard (line 14), he repeated his answer for two more times (lines 18, 22). Only the second time received Audrey's acknowledgement in the form of a thumbs-up (line 19), and this recognition of Felipe as competent through a gesture was momentary and not quite explicit. When Felipe reiterated his answer for the third time, he changed from his previous answer "lung" to the word "lungs", which was just legitimized by Ms. Reed (line 20). This appropriation of a teacher-approved answer signals Felipe's attempt to position himself as competent. In addition, his use of a parallel structure (i.e., "I said lungs, you guys said mouth.") indicated that he positioned himself, Audrey, and Jay as equals and thus competent.

The second example of Felipe's attempt to negotiate a competent student identity happened during the table group's discussion on the Jeopardy question "What functions could migrating from one place to another serve for animals?"

(Jay and Audrey just came back after searching for the answer on the word wall.)

1. Jay: (to Audrey) To survive.
2. Audrey: (to Joe) To survive.

(Joe doodled on his white board.)

3. Ms. Reed: (passing by Felipe's table) (to Joe) If you are gonna be wasting time, then you won't be playing the game.
4. Felipe: To get food.
5. Ms. Reed: To get food? That could be a reason. Yeah. (Left the table)
6. Audrey: (writing) To survive.
7. Felipe: (to Joe) To survive and get food! To survive and get food!
8. Jay: Huh?
9. Felipe: (to Joe) To survive and get food! Ms. Reed said yes.
10. Joe: (to Audrey) XXX
11. Audrey: (to Joe) XXX
12. Jay: (whispered to Audrey) To survive and get food.
13. Joe: What was it?
14. Audrey: To survive. If you weren't drawing freaking hard you'd know.
15. Joe: You didn't say that thing to anyones.
16. Jay: (finished his writing) To survive and get food. To survive and get food. (To Felipe) To survive and get food.
17. (Felipe put up his white board and showed it to table members. His board read "food" and the letter "s".)

In the beginning, both Jay and Audrey agreed on the answer (i.e., "to survive"). As Ms. Reed passed by their table, criticizing Joe for doodling on his white board, Felipe volunteered his answer “To get food” to her (line 4), which received her immediate approval (line 5). Felipe then positioned himself as legitimate discussion participant by combining his own answer with Jay and Audrey’s (i.e., “To survive and get food”) and suggesting the combined answer twice to Jay (lines 7, 9). By involving Ms. Reed and using her approval as a source of authority (i.e., “Ms. Reed said yes.”), Felipe attempted to convince Jay that the added part – i.e., “to get food” - was valid and thus positioned himself as competent. However, only Jay accepted his answer (lines 12, 16). When Jay suggested Felipe’s answer to Audrey (line 12), Audrey ignored him and told Joe “to survive” was the final answer (line 14), therefore rejecting Felipe’s answer and his proposed position as competent. Meanwhile, she also reprimanded Joe for drawing on his board and not knowing the answer. In line 17, Felipe showed his incomplete answer (“food” and the letter “s” that could stand for “survive”) to his table members, which signals that he might want to prove that he had the answer and thus was competent.

As the students were required to write down their answers on their own white boards during Jeopardy and their written answers were deemed as the evidence of competence, Felipe’s inability to spell complete words led to the ascription of a non-writer position by his table members. For example, after the teacher read and approved Audrey’s written answer – “To hide from their predators' preying” – as the correct answer to her question about the function of camouflage, Jay pointed out by using a question that Felipe did not write a complete sentence or word on his board.

Jay: Why did you write 'n' and 'p'?"
Felipe: That's my girlfriend's name.

Here, by referring the letters “n” and “p” as his girlfriend’s name, Felipe authored a playful identity to negotiate Jay’s positioning of him as non-writer and incompetent student.

After the spring break, Felipe was grouped with Jennie, Callie, Jay, and Aria to sit at the same table. This is also the time when classroom tasks became heavily focused on literacy tasks such as developing search questions, doing background research by reading online articles about experiments and science facts, writing down major facts from online articles, developing a hypothesis, writing experiment procedures, and so forth. These tasks were very challenging for an emergent language learner like Felipe. The frequency of individual instruction with the teacher increased. During individual instruction, Ms. Reed often reminded Felipe to ask for table members’ help if he did not know how to carry out a task (e.g., “If you don't know, then you need to ask.”). She also appointed Jennie as teacher by reminding her to offer help to Felipe (e.g., She once asked, “Jennie, can you just point him to the stuff on the screen if he gets lost?”). However, Felipe was never observed to ask for any table member’s help at this table. It seemed that Felipe was reluctant to take on the position of student who needs help with this new group of students (he was also never observed to ask for help from Jay either, who was from his older table group but sat far from him at the new table). Furthermore, the female table members at Felipe’s new table often pointed out his failure and inability to complete various assigned tasks instead of offering help. For example, the following interaction happened during independent work, when students were required to do background research online for their science fair project, using the search questions that they developed and wrote down in their science fair planning packet.

(Felipe was looking at his computer.)

1. Jennie: You’re supposed to do research not anything else. If you haven't did anything, you're gonna ask me all the problems (opened Felipe's science fair planning packet).
2. Felipe: Yeah, but how am I supposed to log in, I don't know XXX
3. Jennie: (looking at his planning packet) You didn't write anything.
4. Felipe: I know.
5. Jennie: You now are supposed to do research (closed his packet and handled it back to Felipe).
6. Felipe: I know::
7. Callie: Then aren't you researching?
8. Felipe: Because I XXX
9. Jennie: You can't research anything.
10. Callie: You can't research anything if you don't have a question.
11. Felipe: I know Callie. XXX anything (showed Callie his login screen) XXX
12. Callie: Cuz you just logged XXX

In line 1, Jennie positioned herself as teacher and Felipe as student by stating that Felipe was off-task and was supposed to ask for her help with “all the problems”. Her action of opening up Felipe’s planning packet signaled her teacher position too. Jennie’s use of “all” positioned her as knowledgeable expert. The clause “If you haven’t did anything” pointed out Felipe’s failure to accomplish anything at the moment, positioning him as incapable. In line 2, although Felipe seemed to accept Jennie’s position with “yeah”, he rejected the incompetent student position by characterizing his problem as having trouble logging into his account on the computer. Jennie subsequently assigned Felipe the nonwriter identity by stating that he did not write anything in his packet (line 3) and the uncooperative student identity by pointing out doing research as his current obligation (line 5). In line 7, Callie joined the conversation, assuming the teacher position through questioning Felipe’s disengagement from the assigned task, and thus positioned Felipe as uncooperative too. In response to Jennie’s and Callie’s negative positioning, Felipe expressed resistance by stating “I know” (lines 4, 6) and defending himself (line 8).

However, Jennie and Callie continued to ascribe the incompetent student identity by making statements about Felipe's inability to do research (lines 9, 10), pointing out his inability to develop a question and write it down (line 10, i.e., "you don't have a question), and refuting his excuse (line 12). In sum, this example illustrates that instead of being offered effective help, Felipe was repetitively negatively positioned at his table by the female table members.

Felipe as struggling and resistant reader and writer. The previous section has shown that when writing was used as evidence of competence, Felipe's inability to write complete words or sentences as well as his lack of language skills needed for carrying out certain assigned language tasks (e.g., develop search questions for the science fair project) were quite visible to his peers and led to his position as non-writer. In fact, in the science fair project unit, Felipe showed a lot of resistance to reading and writing as the number and difficulty of literacy tasks increased. And most of the time, completing literacy tasks for Felipe was a sink-or-swim situation in which he was not provided with adequate support. For example, the following example documented the interaction between Felipe and Ms. Reed when Ms. Reed assigned him the task of developing and writing down a search question for his porous rock project.

(I approached Felipe's table with the camera. Ms. Reed was giving him individual instruction. Felipe took a brief look at the camera.)

1. Ms. Reed: (writing in Felipe's science fair planning packet) So we should be really typing into Google right?
2. Felipe: (no response)
3. Ms. Reed: (speaking slowly as she wrote on his packet) What does porous mean?
4. Felipe: (looking at what Ms. Reed was writing on his packet)
5. Ms. Reed: So when you are researching trying to figure out what your XXX

(Izzy came to Ms. Reed to talk, Felipe stared at the camera while he waited.)

6. Ms. Reed: (tapped on Felipe's shoulder) I want you to figure out a question that has to do with rocks and what you think this experiment is about and write it down. (put a pencil in front of Felipe)
7. Felipe: (making a grimace when Ms. Reed was speaking to him but Ms. Reed was unable to see his facial expression)

(When Ms. Reed finished speaking and left his table, Felipe cursed silently.)

In this example, Ms. Reed first formed the search question “What does porous mean?” and wrote it down for Felipe, positioning him as non-writer. She then asked Felipe to form and write down another search question, which she described as “a question that has to do with rocks and what you think this experiment is about”. This description about the content and purpose of the question was unclear, and Ms. Reed did not provide any instruction for Felipe on how to formulate a question either. Instead of inquiring what question(s) Felipe might want to ask about rocks and experiments related to rocks, Ms. Reed merely asked Felipe to follow her directions and do what she asked. In this interaction, Felipe remained silent at first (line 2), which signaled his resistance to the task of forming search questions to type in Google, and his practices of making a grimace and cursing in the end further indicated his resistance to what Ms. Reed required him to do. This example is typical in that (1) Ms. Reed completed the literacy task for Felipe (on other occasion, Ms. Reed was observed to locate source information, identify variables in the research question, and write down information or answers in the science fair packet for Felipe); (2) Felipe was held accountable merely for listening and answering a very small number of questions (e.g., “So you are going to measure how porous the rock is. Do you know what that means?”) throughout the interaction; (3) Felipe was expected to follow the teacher’s directions without adequate support; and (4) Felipe expressed resistance to the literacy task assigned. Felipe’s resistance and frustration over reading and writing in this classroom was also evidenced by singing in the seat, playing with a pencil, banging the laptop screen shut, etc. These practices often led to reprimand from both the teacher (e.g., “Hey, you are not paying attention right now. You are playing with the pencil I gave you.”) and the female table members. For instance, when Kevin approached Felipe’s table asking if anyone needed help with using key words to develop search questions, Aria pointed out to Kevin that Felipe needed help, saying, “He don't even-, you (Felipe) aren't even writing! And he hasn't even done anything.” By pointing out Felipe’s disengagement from the writing task through the use of the present continuous tense and his failure to complete the task through the present perfect tense, her comment positioned Felipe both as uncooperative and incapable.

Besides the accountability for following the teacher’s instructions to write and the lack of support for such accountability, the English-only policy in Ms. Reed’s classroom was another factor that resulted in Felipe’s being positioned as non-writer. Felipe sometimes used Spanish in writing, but this language was not deemed as a legitimate resource by Ms. Reed. For example, when Ms. Reed checked Felipe’s progress on writing his porous rock experiment procedure (his research question was “What rock is the most porous?”), she required Felipe to write the steps in English.

1. Felipe: I'm done.
2. Ms. Reed: Oh you are doing so good. Ok, (read his packet) Ok, these are all in Spanish. You know that I can't read Spanish, right?
3. Felipe: Yes XXX
4. Ms. Reed: So when you put them on your PowerPoint, are they gonna be in English?
5. Felipe: Yes. XXX put right here.
6. Ms. Reed: Ok, so how far did you get? What step are we at? So we put water in the container, all three containers, right? Then we're gonna take each of our rocks and put them in the containers (using gestures to show

this step). (Felipe nodded.) What, how are we gonna tell how much water gets absorbed? How do you think?

7. Felipe: Uhh XXX (inaudible)
8. Ms. Reed: Yeah, exactly. So if you have a cup full of water right? (Felipe nodded) And you drop a rock in it, does it usually get higher and kinda spill out (use gesture to show "spill out") over the edges right?
9. Felipe: (nodded)
10. Ms. Reed: If a rock has a bit hole in it, do you think it would spill less than a rock doesn't have a hole in it in the middle of it?
11. Felipe: (nodded)
12. Ms. Reed: agree. Ok. So we can tell how many holes are in a rock by how much water comes off the top of the container. (Felipe nodded.) So what you need to do is you need to say to say we are going to measure the water that is left in the cup or that comes out of the cup. (Felipe nodded.) Ok? So that'll be the next steps. (Felipe nodded) And then record your data on the data tables. That's what I want you to write down. (Left Felipe, walking towards Jennie to check her work)
13. Felipe: (started writing)

In line 2, Ms. Reed praised Felipe for completing the assigned task of writing his experiment procedure, but she soon pointed out his use of Spanish in writing. By referring to Felipe's awareness that she could not read Spanish ("You know that I can't read Spanish, right?"), she indicated that writing in Spanish was unacceptable and the rule of using English only. Thus, she positioned Felipe as non-writer who did not meet her expectation of writing in English. By confirming with "yes" in line 3, Felipe accepted this position and Ms. Reed's rule that using Spanish in writing was unacceptable. Ms. Reed then confirmed with Felipe if he was going to type in English in his PowerPoint slides for the science fair presentation, reinforcing the rule of using English only. In line 6, though Ms. Reed asked about Felipe's current progress, she did not offer Felipe the floor to speak about what he had written down. Instead, she immediately continued to explain extendedly the experiment procedure for Felipe, and her monologue about the procedure continued for several turns (lines 6, 8, 10, 12). Ms. Reed's indifference to what

Felipe had written in Spanish positioned him as non-writer again. Furthermore, her extended explanation and practice of confirming Felipe's listenership and understanding by asking yes/no questions further positioned him as having little knowledge about how to carry out his experiment.

During the above conversation between Felipe and Ms. Reed, Felipe's table members overheard that he was writing in Spanish and became curious about what he wrote in his science fair planning packet.

Aria stopped typing and stood up to grab Felipe's planning packet.

1. Aria: (to Felipe) Are you writing in Spanish?
2. Felipe: XXX you can write Spanish but I learn in Spanish XXX
3. Aria: (read his writing quietly)
4. Callie: (looked at Felipe's writing) Why you write so small?
5. Felipe: XXX
6. Jennie: Let me see it. Let me see it.
7. Felipe: No no no no. (took over his packet from Aria) Respect. Don't try to read it. (put his packet on the table)
8. Jennie: (took over Felipe's packet and read)
9. Felipe: (to Jennie) Ooh you can't even read a word I say.
10. Jennie: (trying to sound out a word) XXX
11. Felipe: No XXX (taking back his packet from Jennie's hands)
12. Jennie: You know I can read in Spanish.
13. Felipe: Yes yes. XXX [00:11:00.10]
14. Jennie: I can speak Spanish (proud expression).
15. Felipe: Uh huh::! Ok, how do you say XXX in Spanish then?
16. Jennie: (ignored him)
17. Felipe: Huh? [Speaking Spanish]
18. Jennie: (ignored him, looking at her computer screen)

Aria, Callie, and Jennie asked to see Felipe's writing. Although Callie questioned Felipe why he wrote so small (line 4), Felipe did not seem to care. Rather, he pointed out their attempt to read his written work as disrespectful (line 7), positioning his written Spanish words as mysterious. By stating that he learned in Spanish (line 2), Felipe positioned himself as competent Spanish user. He positioned Jennie as incapable and himself in high status by mocking her, “Ohh you can’t read a word I say.” When Jennie claimed that she could read and speak Spanish, Felipe tested to see if she could speak a certain word in Spanish (line 15), positioning himself again as competent Spanish user. Perhaps, Felipe used this position which afforded him high status to negotiate the non-writer identity he was often assigned.

Research Question 3: Case Study Students’ Perception of Themselves as Science Learners

Drawing on mainly case study students’ interview data, I present in this section analysis of how Camila, Lucas, and Felipe perceived themselves as scientists and as science students. Both the students’ drawings and their narration of their own experiences related to science and learning, though it may appear truncated sometimes, provided valuable insights about their self-perceptions and understandings of being a scientist and being a student.

Camila

Camila as Scientist. Camila remained very nervous and reserved when she participated in the initial interview, often observed to fidget and blink her eyes. She became much more confident and eager to share her ideas about science and her experiences in the science class in the final interview. Sharing useful information with others made up a significant part of her construction of herself as a scientist, and this had much to do with her experience of developing and presenting her science fair project on bacteria (her research question was: What location in a school will produce the most bacteria?). She chose the squid dissection that she did in Ms. Reed’s class to represent herself as a biological scientist working in a group. Furthermore, she seemed to perceive that being a scientist overlapped with being a good student in the science classroom.

Camila as a scientist who shares useful information. During the initial interview, Camila drew a picture of female scientist (Figure 3). She explained that the scientist in her picture was "ready for doing science stuff" and "ready to learn and teach", and then specified that by "science stuff" she meant "do experiments" and "dissect things, like a sea animal". When asked to draw a picture of herself as a scientist, Camila drew two female people standing next to a dinosaur fossil on display (Figure 4). She pointed out that the female person on the left was her and that the one on the right was a scientist. Instead of depicting herself as a scientist, the picture reflected Camila's experience of visiting the museum as a student. As she explained, "Mmm this was me with a scientist. The scientist was explain like a bone, like a XXX dinosaur in the museum… Like talking to me about bones and how they found." Thus, Camila perceived that scientists present to people how they research something and the facts about it. When I tried to confirm if the picture represented a moment when she thought she was a scientist, Camila responded, "I wanna be like her."

Figure 3. Camila's drawing of a scientist in the initial interview

Figure 4. Camila's drawing of herself as scientist in the initial interview

In the final interview, when asked to draw a picture of a scientist, Camila depicted a scene in which a teacher explained to her how volcano eruptions happen using a display board with a picture of an erupting volcano (Figure 5). She labeled the stick figure in the middle of the picture as "the teacher or scientist" as she explained what was happening in the picture. The scientist/teacher mixed a potion that simulated chemical reactions that take place inside an erupting volcano and was "showing her experiment" and "explaining what we'll do like step by step like we can (do) science experiment like that." In relation to the scientist, Camila described herself as a student who was "surprised and excited" to learn about volcanoes. She was imagining what a volcano eruption would look like in real life while listening to the scientist.

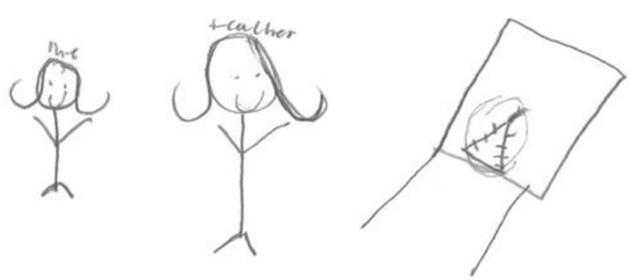

Figure 5. Camila's drawing of a scientist in the final interview

Camila's choice of showing a teaching scene with herself and a scientist suggested she might perceive teaching or delivering scientific facts as an important practice that scientists engage in. In fact, Camila reiterated the idea that scientists share useful information with people in her talk about what scientists do. For example, she elaborated on how scientists risk their lives to inform people of natural disasters and help evacuate people when there is danger:

> like geographic people, like they are scientists. They go through every natural disaster they go through-, like to tell people when there's a hurricane, people like-, people go through-, they are-, they are on danger to look at-, people be safe. And sometimes, sometimes scientists like put rr-, put risk on lives, not really bad but people where(?) they leaves off country or state have volcanoes, and they say "Ok, it's gonna happen in one hour or 5:30." And they're gonna get all the stuff ready.

Camila associated talking about scientific discoveries and informing people of safety issues with her sense of self as a scientist "Some scientists talk about like germ and bacteria [like] what I did. People-, like some of the germs on your shoes. They figure out to be safe with something," Camila said. She seemed excited about visually presenting her science fair project on bacteria on the display board. "I took a picture of my materials… and everything else I was planning XXX organize are actually came true." Camila told. When seeing people "in shock at what I did" at the science fair, Camila stated this made her "happy inside" because "people love the experiment when I did and XXX safety from the bacteria." During her science fair presentation, she gave parents advice such as "tell your kids to wash their hands" and "if you want to take a shower, to make sure there is no bacteria." Furthermore, when asked what kind of science student she wanted to become in the future, Camila expressed her desire to discover another planet in the space and to do a science project that answers a question such as "How many years does it take for rocks to form?" She wanted to research things and to be like Ms. Reed who "give us a question and then give us information".

Camila as a biological scientist. In the final interview, Camila represented herself as a scientist by drawing a picture of herself and another female group member carrying out the squid dissection together (Figure 6). In the picture, the female group member said, "I'm going to cut it now," and Camila responded "Ok." She gave a step-by-step description of how she and her table members conducted the squid dissection, which involved putting on the gloves, cutting the squid open, poking the siphon, and pulling out the claws with a tweezer (which she referred to as "the little pointed thing"):

Camila:	So like a long time ago, like it was uh::: (thinking) I don't remember what month it was. So we were learning about squids and we gonna cut it open. And right here it was- (looked at her drawing, moved it closer to me) Look here it was a XXX "I'm going to cut it." Like we cut up a squid. And I said, "Ok." (pointed to her picture) So this is squid and XXX poke it XXX squirt I think [she seemed to talk about the siphon]. I don't remember that much. This is a squid, cutting it open. We went to Ms XXX a science teacher upstairs for middle school. (3.0) uh then (1.0) We were sitting down getting our glove-, we put on gloves. We got a little knife, like a knife to cut it open. We cut open the head and (1.0) and I-, me-, so we got the little pointed thing, you know XXX it's kinda like that. We opened it and we tried to pull it out, and I pulled it out. (4.0) Then um=
Xue:	=Just wondering what did you pull out? Is it something like...?
Camila:	It was like a-, you know=
Xue:	=Intestines?
Camila:	Yeah like that. Like you know when like XXX like their claw. That was like that. Then I took it out and put it on the side.

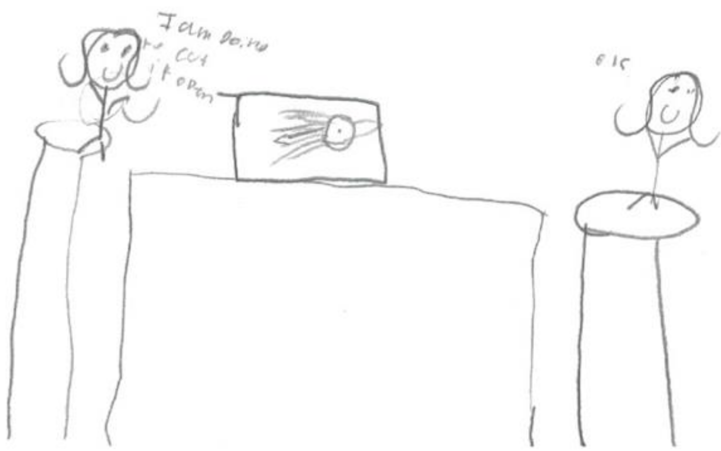

Figure 6. Camila's drawing of herself as scientist in the final interview

At the end of her description, Camila added, "It was fun because first time seeing a squid in real life and opening it, what's inside. It's not like really seafood, something like fish." Thus, she separated the scientific practice of dissecting and learning the structure inside a squid from seeing "seafood" in everyday life. In addition, for Camila, the use of tools is indispensable for scientists when they conduct experiments and dissections. When asked how she would describe herself as a student in the final interview, Camila first mentioned that she felt like she was "in a scientist laboratory" which was not like "normal classes" and that "Ms. Reed was like a teacher from a science lab". And she continued to comment, "When we did anything, like the squid, I felt like a scientist opening the squid. I feel like a scientist, because when you do something, experiment, you get goggles and a suit, then you get gloves, because scientists actually use gloves to do their experiments and take notes."

Intertwined aspects of being a scientist and being a good student. Apart from disciplinary practices such as doing research, disseminating information, and conducting dissections, Camila's perception of herself as a scientist also included complying with classroom norms. When asked if there were any scientists around her, Camila nominated her friends Jane, Alicia, Audrey, and Jennie. She thought of these friends as scientists because they had “a good answer”, gave explanation about scientific terms (e.g., eruption) when asked by the teacher, got answers from a paragraph, double-checked their answers, “take their time” to “do their work”, shared classroom materials such as pencil and paper, and were nice to other people. With respect to doing the work, being nice, and sharing, she made clear connections between scientists and herself:

> And they (scientists) do their work, they take their time, like when I did my science fair project, their boards.
>
> we are sharing::, like, like scientist actual actual share their materials like, like if you don't share, it's not nice for the other people, for your friends, like "I'll give you this. Here, you can borrow my pen." Sometimes scientists are always nice to their partners like...
>
> I'm sharing like-, sharing my snack… People say sharing is caring, like that. And I feel like Jennie, almost everybody's like a scientist, also me.

Camila as Science Student.

A motivated learner. Camila demonstrated being a motivated learner by expressing her interest in learning about multiple topics and things to do in the science class. She was excited about growing plants, dissecting a real squid and seeing what is inside, and reading paragraphs about the structure of the squid. She was interested to learn how things and people from the past, such as “Ancient Greece, Egypt, and fossils”. She told, “I really like to know people from a long time ago in the past, how did it happen, and how many years. It’s something like a rock like in the Grand Canyon and how much years it would be.” She was also excited for her science fair project. She showed enthusiasm about her data collection and observation as well as the final presentation of her project. “I’m excited to see bacteria, like red and black bacteria. I was excited for showing people what I did and what I collected, my data observation. And people were like, “Ooh, bacteria.”” Camila said. In addition, she identified science as her favorite subject and commented, “I never got frustrated in science.”

Additional evidence for Camila being a motivated science learner is that she attached high importance to receiving education. She stated, “if we didn’t go to school we won’t learn.” She considered reading, math, and science as important subjects and expanded on the consequences of not learning these subjects at school. For example, she believed science was important because:

> If you plant, like um (thinking) a seed, like a plant, like a flower, or we (pause, thinking), it um... you have to know how you're gonna plant it and you're gonna water it once a day. When the soil is not moist, you have to put water once a time. If you don't know, you'd just do it every minute every hour.

Furthermore, Camila regarded going to college as a necessary path towards getting a job and building a career. Camila stated, “If you wanna go to college, you need college to go to get your career.” For her, going to college would help her figure out what kind of job she would like to pursue. “If you don’t go (to college), you will not know what you’re gonna do.” Camila stressed. She claimed that learning various scientific facts in Ms. Reed’s class made her think that she wanted to become a doctor or nurse in the future.

A learner making progress. Camila showed a great extent of awareness of her progress as a science learner. She talked about her transition from a confused learner at the beginning of the fourth grade when she first started learning science to a successful learner that she was becoming right now. She talked about her experience of learning about the different layers of atmosphere in the fall semester and difficulty with locating answers in a text:

> Learning about the layers of atmosphere:
> … but sometimes I forget the layers of the atmosphere. (2.0) And um (2.0) um, when I first [tried to] understand it, I was like uhhh:: (acted being confused), I was confused, over (1.0) months passing by, like, my god, look at what I did couple months ago. I remember like, I XXX [00:39:08.17] these questions. XXX It was hard for me doing it. And over time, I got surprised and I've done my work, like I got through all papers XXX [00:39:22.10], and whoa. I change XXX this year. I know a lot of thing than the past. I feel like I accomplished everything in science.
>
> Locating answers in a paragraph:
> When we read it, read like a passage XXX the answer, it's really hard to find probably like a long paragraph or long whole story. And we can't, I can't find it. So it's really hard, And I'm trying to get better at it… Ms. Reed sometimes help us, "Oh, it's in paragraph three." We're gonna read the sentence and I find it. And like sometimes I need help finding it, I ask my partner and she said, "Oh it's in this one, this paragraph." XXX It doesn't get harder and it gets easier to me.

Based on these descriptions, Camila's sense of self as a successful learner was closely associated with knowing and remembering more scientific facts and performing better in classroom tasks. She seemed to regard learning science at school as a process that involves possible confusion and difficulty at the beginning but leads to the comprehension, remembrance, and mastery of knowledge and skills in the end. In addition, Camila considered that to get better at science involves putting in effort. For example, she mentioned that she spent time on learning and writing about planets:

> I'm really good at anything. Like, when he asks about planets, I already know it, because one time we were talking about planets, and I did a whole packet and wrote about the sun and any planet, and I shared it to my class, and Ms. Reed was surprised that I did that, and I took my time.

Camila's reflection on her progress in science over the year also indicated she was becoming a more confident learner. She expected that learning something unfamiliar such as the rocks could be hard in the beginning, but she believed that as she "learn more and more", it would get easier and she would remember what she learned. As she commented,

> First when I started, I don't understand this (unclear referent). I don't get it in my mind. I needed help from my friends. And then after, I was getting more and more, and learning about different things. Right now, I'm finding a little bit hard to deal with the rocks, but in a couple more days, when we go to the field trip, we will learn more and more. I think, "It's easy now, I remember it."

A good student. Camila considered herself as a good student in the science classroom with regard to both academic performance and classroom behavior expectations. Academically, she identified herself as "a good describer" and "a good reader". She related being a good reader to finishing reading a paragraph fast and locating the answer quickly:

> Like when she (Ms. Reed) says, "Read this paragraph." I will read it and sometimes you have two minutes or three, she says, "Raise your hand when you finish so the other ones could read that paragraph. Now finish." I'm like finish in a minute and read it over and over again like, like I know the answer right away. I am like a good reader I think.

When asked how she thought Ms. Reed would describe her as a student, Camila responded that the teacher would describe her as "a good student", "a good listener", "a good role model". And Camila thought her classmates would describe her similarly as Ms. Reed. Her reasons for identifying herself as a good student concentrated on meeting the behavior expectations that were reinforced in the classroom, such as listening, never shouting or talking over the teacher, raising one's hand to speak, following the instructions, completing one's work, and so forth. As she said,

> She (Ms. Reed) would describe me as a [good] student because I don't shout out ever. I never talk over her. I will always raise my hand. I never lose my place, and I never disturb other people. I never get in trouble for anything. I'm a good student for her because she always picks certain people, and she also likes people

> describing – I think she would describe me as a good student, and not being bad, not getting in trouble with her, finishing all my work. I follow her instructions.

Camila thought of herself as a good helper for the teacher and her classmates too. She mentioned she helped Ms. Reed pick up used paper towels and put away the markers on the tables after jeopardy when Ms. Reed asked for help from the students. She thought her table members would describe her as “nice and helpful”. Camila said that she helped her table members by showing her notes when they missed school, reminding them what they forgot to write down in their worksheet, and pointing it out when they did not follow the teacher’s instructions correctly. Camila gave the following conversation example of how she and her table member Jane helped each other:

> "Oh you forgot to write this in the white board or in your notebook." "Oh thank you for telling me or thank you (for) listen correctly." And this said, like when I was doing something wrong, "Oh you are supposed to cut this." Jane said, "Oh no." like when Ms. Reed said, "Oh if you've cut it, it's fine." All my classmates could be helpers too. If they forgot, like they cut the wrong thing, "Oh you forgot those." XXX Ms. Reed XXX, "Oh it's fine. You can do it your way."

Helping others by reminding what they were supposed to do also overlapped with how she described her role model, Alicia, helped other students. Camila stated, “They (role models) tell people, “Oh, you missed this thing.” Real scientists, if they don’t do their work, they get in trouble. So, she’s (Aniya) trying to make sure people, that they know what they have to do when they are scientists.”

Lucas

Lucas as Scientist. Among the three case study students, Lucas was the only one who used inspirations from movies to construct his images of a scientist. His drawings of a scientist featured a robot from the future and aliens. He associated hands-on explorations with being a scientist, but he did not identify himself as a scientist because he did not possess a large amount of knowledge.

I do hands-on explorations but I'm not a scientist. Lucas saw himself as a scientist when he was dissecting a squid and when he was doing his squishy egg experiment for his science fair project. He proposed the squid dissection as "the only time" when he thought of himself as a scientist in both the initial and final interviews. When asked if he also considered himself as a scientist when he was working on his science fair project, Lucas responded, "I guess, probably." Figure 7 shows Lucas's drawing of himself and other classmates working in groups to dissect a squid. Lucas described, "I have a XXX knife and then I was getting- I opened the squid to see inside of it and didn't really want to so that's why I have like a scary face." Lucas was standing on the right side of the picture with a knife in his hand and was wearing "a jacket" which he at first described as "protection gear". According to Lucas' account, he also noticed that the girl from a next table was scared too. This is likely why all the other students in the picture had the similar scared face as Lucas. When asked what he observed about the squid, Lucas stated that he saw "the black thing inside" but he did not know what it was called. He perceived himself as a scientist because he felt like he was doing "real science" and scientists dissect squid "alive". For Lucas, dissection was a scientific practice which required using the knife as a tool, wearing a protective coat, and cutting open a creature to observe what was inside.

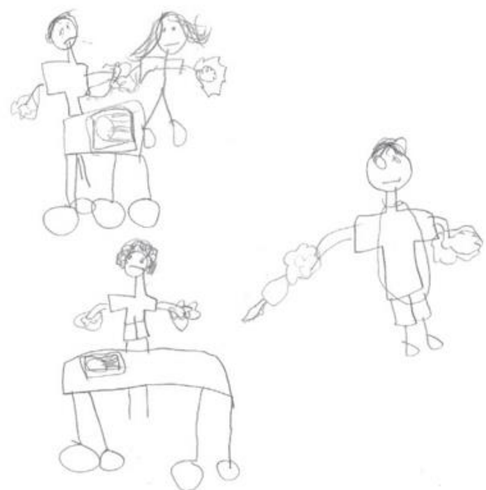

Figure 7. Lucas' drawing of himself as scientist in the initial interview

Figure 8 below depicted Lucas as he was doing his squishy egg experiment at home. When asked why he saw himself as a scientist in this picture, Lucas responded, "Because it was a really good science experiment and science experiments make you like a science, kind of." In the picture, Lucas was lying on the floor, "holding" and "looking at the egg". Lucas described, "I was looking at the egg like this. Like that, and then that's the inside of the vinegar. And then, after 24 hours, the egg is squishy now." His drawing contained important information about his experiment such as procedure (i.e., an egg was first placed outside the container with vinegar and then soaked in the vinegar), duration ("after 24 hours") and materials ("egg in vinegar") as well as the observations made by Lucas. Although he did not address in his verbal description that there were lots of bubbles around the egg when the vinegar reacted with the eggshell, he represented this observation through drawing. And near the text "the egg is squishy", Lucas drew a whole egg that turned squishy and a yoke. "That's me squishing it." Lucas explained. He seemed to want to represent the rubbery quality of the egg, which was the result of his experiment, through the movement of his hand in the picture. Thus, for Lucas, doing an experiment as a scientist involved following a procedure and making observations.

Figure 8. Lucas' drawing of himself as scientist in the final interview

Interestingly, the images of scientists that Lucas represented through drawing in both the initial and final interview were based on his imagination and inspiration from movies, though he could not recall the name for one of the movies. Both the scientists he drew during the two interviews used chemicals (Figure 9 and Figure 10). Perhaps chemical reactions or using chemicals to make things interested Lucas, and this interest might have led to his choice to do the squishy egg experiment for his science fair project. In Figure 9, based on Lucas' description, the scientist was "making chemicals" for doctors "so like if someone's sick he will feel better like in the next day probably". The chemicals were represented as liquid in flasks on tables. The scientist was assisted by a robot from future, who not only helped with fetching things needed for making chemicals but also giving instructions for the scientist to make the cure. Lucas narrated, "so since he's (the robot) from the future and he (the scientist) doesn't know stuff from the future, he's gonna move time to make something that's from the future because right now they don't have that, so he's (the robot) gonna tell him to make it and he's (the scientist) gonna make it." In Figure 10, with an alien skeleton in the background, Lucas drew a scientist who was trying to find out why aliens were green and what kind of chemical made their skin green. For these purposes, the scientist was conducting "kind of like a DNA test" or "some blood tests".

Figure 9. Lucas' drawing of a scientist in the initial interview

Figure 10. Lucas' drawing of a scientist in the final interview

Although Lucas connected his hands-on explorations with being a scientist, he did not perceive himself as a scientist for the reason that he did not possess a high level of expert knowledge. He identified Ms. Reed and the student Kevin as scientists because they both knew “a lot of science stuff”. He claimed that Ms. Reed wanted to be in NASA and that “if you wanna be in NASA, you gotta know a lot of science.” He also claimed that some of the science stuff that Kevin knew were “too hard for him”. “I think he takes sixth-grade science,” Lucas said. However, Lucas suggested a contrast between himself and Ms. Reed and Kevin in terms of the level of science knowledge by saying, “I’m not a scientist because “if I'm a scientist, I would know a lot of science, but I do not know that much science.”

Lucas as Science Student.

A tactile and visual learner. The science class interested Lucas because it allowed him to do “a lot of cool stuff” and to “have more new experience”. For Lucas, to do, to see, and to experience made up the intriguing part about learning science. Lucas claimed that he liked “all the activities we do” in the science class this year. He stated that Ms. Reed’s class was “really fun” because “we do like a lot of experiments.” Lucas was excited to dissect a squid “because I never did that”. He was excited that he was able to plant plants with friends and felt frustrated when someone destroyed their plants. The “fun field trip” to the downtown science museum engaged him because “we were able to go play with science stuff” and “we were able to see experiments” and “we were able to see the world from looking at the globe”. Lucas nominated the rock activity in the beginning of fourth grade as the activity he enjoyed the most, and he learned that rocks “sound different when you shake them in a cup”. In addition, Lucas stated that he felt “confident” because he knew “a little bit about stuff she (Ms. Reed) taught us from

YouTube". When he recalled the YouTube videos in which a "Science Guy" did science experiments, he described:

> It was something on YouTube. It was a show on YouTube that this Science Guy, he was doing a lot of science experiments. And he was teaching a little bit of science… I don't remember how he did it, but he had this long stick. No, it wasn't a stick. It was a cup. He had a cup. And then, they were holding it. And then, he put this chemical in it, but he still had it in his hand for 20 seconds. And when there was 5 second left, it turned brown.

Lucas' memory and account of an experiment video on YouTube that he had watched may indicate his interest in watching people doing experiment.

An academically passible student. When asked if he was good at science, Lucas responded, "No, I don't think, but I really like it a lot. I think I'm okay, I'm okay I think." He gave consistent responses when asked how he thought Ms. Reed and his classmates would describe him as a student by saying, "Probably she thinks I'm okay, probably," and "some people think I'm okay". He also thought that his classmates might describe him as "kind of smart", but he signaled his hesitancy by saying "I don't know". Although Lucas appeared to not identify himself as "smart", he expressed that he wanted to be "the smartest" in the science class. In addition, Lucas made a comparison in terms of how his classmates thought of his performance between math and science by saying, "In math, it's kind of worse. Some people think I don't know that much." He rejected the negative comment from his peers that he was poor in math. Lucas stated, "Some people like Pearl think I don't know nothing, but which I do. I know some things in math."

Lucas was not a confident reader in the science class. He claimed that he was probably good at reading in the English language arts class and was sometimes good at reading in the science class. He admitted that reading a text and finding facts from it quickly was quite challenging for him:

> Uh, what's challenging is there is like a lot of stuff to do like we have to do facts and read this. We have to have it – like we have a timer to do it really quick, so we have to have a timer. If you don't have it by the time we have to do the next thing, we have to think fast, kinda like do it quick as you can.

Not only did the time limit on reading tasks in the science classroom pose a challenge, Lucas also admitted that sometimes the texts had "a lot of new words" that he had "never seen" and thus did not know.

A student meeting classroom behavior expectations. Lucas described himself as "a good listener", "good at listening", and a student who "listen closely for instructions" and "mostly do my work". He also associated the practices of paying attention, listening, and following instructions with being a good science student. When asked which project he felt proud about so far, Lucas chose the squid dissection because his table group followed the teachers' instructions successfully and quickly. Lucas explained, "The whole group followed directions… She (Ms. Reed) told us what to do and then we started following her and when she said "stop", we stopped because some other kid was just going slow." For Lucas, the prerequisite for doing an experiment successfully in the science class was paying attention and listening to the teacher's instruction closely. He stressed, "when we do experiments, I have to pay very close attention because or else I'll do it wrong. And I might have to restart. So, I have to listen very closely."

A helpful partner. When asked how his table members would describe him, Lucas thought that they would describe him as "doing good" and as someone who always helped them. He hoped that he and his table members would be nice rather than "getting mad at each other" even if they as a group did something wrong. He also described himself as a polite partner who considered others' needs. When asked what made him a good table member, Lucas responded, "If they (his table members) wanna do something, like if I'm gonna do it, but it like – if the teacher tells me to do it and they wanna do it, I let them if they wanna do it because I feel bad (if I do it first)." In the final interview, he explained how he helped other students by giving two examples – one was cutting the squid for a table member who found it hard to handle a slippery squid, and the other one was telling his friend Caleb how to plant seeds:

> Cutting the squid for a table member:
> Because this one kid in my group, he didn't know what to do. So, I gave him the knife and said I could cut it for you. He gave me the little knife. And it was right here that he has to cut it, and he couldn't because it was so slippery. So, I have to get it hard so it doesn't slip. So, I had to cut it.
>
> Helping Caleb plant seeds:
> like that one time, where we did our plants, he didn't listen very well. So, I had to tell him when we had to spread out the seeds to make sure they are separate. And then, bury them inside the soil.

In these accounts of his experiences of helping others, Lucas used "have to"/"had to" multiple times (e.g., "I have to get it hard so it doesn't slip.), which showed that Lucas regarded offering help to others when they needed it as an obligation.

Felipe

Felipe as Scientist. Felipe's ideas about scientists and what scientists do evolved during the time between the initial and final interviews. Compared to the scientist image that he drew during the initial interview, the scientist image he drew in the final interview was more concrete and reflected his learning experience during the science fair project unit. He chose different learning events to feature in his drawings of himself as scientist during the two interviews. His drawings of himself as scientist along with his explanation of these drawings and responses to my interview questions about scientists revealed both similarities and differences between himself and scientists.

I do what scientists do but I am not a scientist. In the initial interview, Felipe drew a scientist image (Figure 11) with an Einstein hair style and pens in his pocket. The scientist was holding a pen in one hand and a notebook in another. When asked why he drew the scientist' hair style like that, Felipe suggested in Spanish that he got the inspiration from a picture of a scientist in Ms. Reed's classroom ("Nada más vi un dibujo ahí que tenía así el pelo." i.e., "Nothing else, I just saw a drawing there that had hair like this."). Felipe explained that the scientist in his drawing "discovers something" and was "drawing it down". When asked if there were things that scientists do that he did not put in his picture, Felipe added, "They help kids to learn more stuff." Thus, Felipe associated the possession of more knowledge with scientists and included the practice of teaching kids into what scientists do. This was perhaps the reason why he identified Ms. Reed as a scientist. "Because she teaches things that we didn't know before," Felipe explained, in response to the question what makes Ms. Reed a scientist.

Figure 11. Felipe's drawing of a scientist in the initial interview

When asked if he was a scientist, Felipe first responded "no". As he clarified, the practice of teaching that scientists engage in was perhaps what distinguished him from a scientist ("I don't help kids like a scientist"). However, Felipe refused to further explain why he was not a scientist when requested by Mrs. Bain, who was his home classroom teacher and helped with Spanish-English translation during the interview.

Xue:	They help kids to learn more stuff? Okay. Are you a scientist? No? Why?
Felipe:	I don't help kids like a scientist.
Xue:	Sorry, I didn't catch that.
Felipe:	I don't help kids like a scientist.
Xue:	You don't help kids like a scientist.
Mrs. Bain:	Like a scientist? Si quieres decirlo, en español también puedes explicarlo. *(Like a scientist? If you want to tell it, you can also explain it in Spanish.)*
Felipe:	No.

Felipe seemed to be confused when I requested him to think of a time when he thought he was a scientist. "When I'm a scientist?" Felipe asked, which could indicate he did not identify himself as a scientist to some extent. When I rephrased my question by asking him to think of a time when he did science stuff, he replied, "When I was dissecting a squid," and drew a picture of himself dissecting the squid (Figure 12). In the drawing of himself doing science, Felipe was standing in front of the squid on his table and holding a "butter knife", which he explained was the tool he used to dissect the squid. "I was cutting the squid, cutting him from here until his back." Felipe described. He agreed that scientists dissect animals like he did in the picture. When asked if he discovered something like a scientist during the squid dissection, Felipe confirmed and responded, "When I did this, the colors changed." Thus, Felipe associated the practices of dissecting animals and making discoveries with doing science, although he was not fully convinced that he was a scientist. However, Felipe did not associate giving a presentation with what scientists do. When asked if he felt like a scientist when presenting his blowfish diorama project to the class, Felipe responded, “I don’t. I just presented my project.”

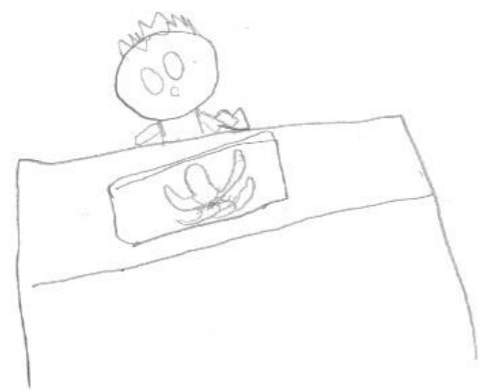

Figure 12. Felipe’s drawing of himself as scientist in the initial interview

In the final interview, Felipe’s drawings of a scientist and himself as scientist had common elements (Figure 13). Both drawings had a scale and a poster board with the word “science” in approximated spelling. Although Felipe did not remember the word “scale”, he referred to the scale in his drawing of a scientist as something scientists used “when they were measuring the rocks”. As I asked what the rectangular thing he drew at the bottom was, he pointed out that was a posterboard. “After she measured the rocks, she took pictures and put them there (i.e., the posterboard).” Felipe explained. Felipe’s description of what the scientist in his picture did reflected his classroom experiences when he was working on his porous rock project. Under Ms. Reed’s instructions, he learned how to use a scale to measure the weight of different types of rocks before and after they were soaked in the water for twenty-four hours. He took pictures of his experiment materials during his experiment and put them on the display board to be presented at the science fair. However, despite the common elements shown in his drawings of a scientist and himself as a scientist, Felipe again showed hesitancy over the question if he was a scientist.

Figure 13. Juxtaposition of Felipe's drawings of a scientist (left) and himself as scientist (right) in the final interview

Like in the initial interview, Felipe first responded "no" to the question if he was a scientist. But as I asked him to tell me something similar between him and a scientist, he responded, "They have this thing – I measured the rocks with that." "And I did a booth in the science fair." Felipe immediately added. His response indicated that he perceived what he did for his science fair project – measuring the weight of rocks with a scale and setting up a display board for presentation at the science fair – was something that scientists also engage in. Felipe showed unsureness again when I was eliciting how he thought of himself as a scientist in his drawing:

Xue:	Oh, okay. Let me see. Can you tell me how do you think of yourself as a scientist in this picture, like what makes you think so?
Felipe:	I don't know if I'm a scientist.
Xue:	You don't know if you're a scientist?
Felipe:	Yeah, I don't know.

For Felipe, what scientists do encompass more than what he engaged in in Ms. Reed's classroom. Perhaps this was the reason why he did not identify himself as a scientist. When asked if scientists study anything other than the rocks, Felipe responded that scientists also study volcanoes. He explained that scientists study volcanoes by sending "a little car" to go inside a volcano so "they can see the volcano stuff" from "a science center". When I asked if the little car carries a camera, he continued to explain, "Yeah, so they (scientists) can measure that the volcano is gonna erupt again or if it's never gonna erupt again." Furthermore, Felipe stated that what scientists do was more complicated than what the students did and what Ms. Reed did in the classroom.

Felipe as Science Student. Felipe seemed to hold positive attitudes toward school and Ms. Reed's class, though he used words sparingly, often offering one-word or two-word answers. He felt "good" about school and felt "fine" about Ms. Reed's class. He responded "No" when asked what was challenging about learning science, if there was anything that he did not like in the science classroom, and if he had ever felt unhappy or upset about learning science. He said, "I enjoy when we learn different stuff," and "I like everything they do". Felipe described himself as a "good student" but replied "I don't know" when I asked how others would describe him as a student. Although his responses remained truncated throughout the two interviews I conducted with him, he was willing to offer more details when he talked about his experiences of working with his uncle and aunt on his blowfish diorama project and working with table group to assemble their Mars rover. In addition, he mentioned being offered help by different teachers with his science fair project.

A possibly good student. When asked how he would describe himself as a student in Ms. Reed's classroom, Felipe responded "Good". His perception of himself as a good science student was closely related to fulfilling classroom behavioral expectations. "I listen to the stuff she (Ms. Reed) says, and I do everything she says." Felipe told as he explained what made him a good student. Felipe did not perceive himself as a confident learner, as he said, "I don't know if I'm good at science". Felipe responded "I don't know" when asked how Ms. Reed and his classmates would describe him as a student. Due to his emergent English proficiency, to describe himself in this language could be daunting and abstract for him. Perhaps Felipe was not fully convinced that he was good science student or was reluctant to reveal how the teacher or other students commented on him, as he often received criticism from both the teacher and table members due to his failure to meet classroom behavior expectations.

A tactile learner. Hands-on projects seemed more intriguing for Felipe. He nominated his blowfish diorama project as the one he was proud about and stated that he liked the table group activity in which they assembled their own Mars rover to compete with other groups. He was more confident and willing to tell more about how he made the diorama and what he and his table members did when building the Mars rover. In contrast, when asked which part of his science fair project he enjoyed the most and did his best, he responded, "I don't know."

Felipe shared in Spanish that he was proud about his blowfish diorama project because he made the house and the bed where he lived ("Porque hice la casa y la cama en donde vive") and their food ("Su comida y…"). He was also proud because Ms. Reed praised him, which was out of his expectation. "I was scared I was going to do bad," Felipe said. He told that both his tío (uncle) and aunt helped him with the diorama project. His uncle told him "what to buy" and "how to make a blowfish" and made the blowfish figurine for him. And his aunt bought the "fake food" for his blowfish. Felipe's preference for this diorama project and his interest in animals could be evidenced by his readiness to tell what facts (e.g., habitat, behaviors, food consumption) about the blowfish that he shared with his classmates during the presentation.

Xue:	Only the picture? Okay. Did you learn more about blowfish when you were doing the project? Can you tell me what did you learn about it?
Mrs. Bain:	Remember you presented your project? What did you talk about when you presented your project? Cuando lo presentaste a todos, ¿Cuáles fueron los detalles que compartiste con tus compañeros de clase? *When you introduced it to everyone, what were the details that you shared with your classmates?*
Felipe:	Que si toca algo se hacen grandes. *That if it touches something, they become big.*
Mrs. Bain:	When it touches something, it blows up. ¿Qué más? *Anything else?*
Felipe:	Que come crabs, no me acuerdo como se llama. *That it eats crabs, I don't remember its name.*
Mrs. Bain:	It eats crabs. He's not sure of the name but they eat crabs.
Felipe:	Viven al fondo del mar. *They live at the bottom of the sea.*
Mrs. Bain:	They live deep in the sea.
Xue:	That's good information.

When asked what role he played in his group, Felipe told in Spanish that he put the tires on the Mars rover constructed by his group in class in November. Felipe regarded the task of putting on the wheels as his responsibility within the group. “I had to grab them (i.e., the wheels) and then put them on. I had to grab the band to put them all together.” Felipe said in Spanish (“Tuve que agarrarlas y luego ponerlas. Tuve que agarrar la cinta para poner todo junto.”). Felipe further described the working processes of his group which involved building and testing: “I built the wheels, then there were more people; I remember they building the car so I can put the wheels on it. We were testing on the floor, and then we went outside to have a competition.” Based on his description, Felipe was also putting in his effort when putting on the wheels for their rover. “When I put the wheels in because that was my job, I put it hard so they didn’t get off, and we won.” Felipe told, contributing the group’s win in the whole-class competition his effort into putting on the wheels and making sure they stayed in place. He confirmed that his group’s Mars rover traveled the longest distance and reached the finish line. And he reiterated that the wheels on other groups’ rovers fell off, while his group’s did not. His telling indicated his enthusiasm and confidence in this hands-on activity.

A learner supported by different teachers. Felipe realized that he received help with learning science from Ms. Reed, Mrs. Bain, and the teaching aid Katie in Mrs. Bain’s classroom. He stated that he felt good about Ms. Reed’s class because “she helps with everything.” According to Felipe, both Ms. Reed and Mrs. Bain were involved in assisting him with soaking the rocks into water, measuring the weight of them, and making the display board when he was working on his science fair project on porous rocks. “I worked on a poster and I didn’t know what to do, so she (Ms. Reed) helped me, and it was different. I liked it.” Felipe told. Mrs. Bain also helped him record the weight of rocks in paper (Felipe probably referred to his data table as “paper”), “take a picture of the paper”, and “put them on the display board”. Felipe admitted that typing his project information (e.g., the research question, experiment procedures, conclusions, etc. in the Google slides was “the most hard” part. Both Ms. Reed and Katie helped with Felipe’s slideshow. In addition, Felipe denied that he wrote the presentation speech by himself and mentioned that Katie helped him write the speech. “So I was telling her, and she was telling me how to write it.” Felipe said. Therefore, Felipe perceived him as a science learner receiving help from different teachers.

CHAPTER 5

DISCUSSION AND CONCLUSION

Summary of Findings

With the goal of exploring English language learners' academic identity development in the science classroom, my study was guided by three research questions:

RQ 1: What are the common classroom procedures present in this fourth-grade science classroom and what are the celebrated and marginalized practices within these procedures?

RQ 2: What science-related identities do focal ELLs develop through classroom interactions?

RQ 3: How do the focal ELLs perceive themselves as science learners?

To answer these questions, I analyzed classroom observational data collected over the course of two months and interview data with three focal ELL students. This section presents a summary of findings.

RQ 1: What are the common classroom procedures present in this fourth-grade science classroom and what are the celebrated and marginalized practices within these procedures?

I identified six classroom procedures that frequently occurred in Ms. Reed's fourth-grade classroom, which were lecture, whole-group I-R-E, guided notes, Jeopardy, table group discussions, and independent work. My findings show that except table group discussions, all the other five classroom procedures emphasized classroom behavioral norms such as listening, paying attention, raising hands to respond or ask questions, sitting properly, and following the teacher's directions. Practices that signal a student's failure to comply with classroom behavioral codes, such as interrupting the teacher, having side conversations, refusing to write down notes, and making distractive noise, were marginalized through scolding and warning from the teacher and criticism from the peers. With respect to learning the science subject, the practice of telling the right answer was celebrated in whole-group I-R-E and Jeopardy and seemed to be the only way for students to demonstrate scientific competence in science in the classroom. Therefore, being “competent” or “a good science student” was narrowly defined in Ms. Reed’s classroom.

RQ 2: What science-related identities do focal ELLs develop through classroom interactions?

My findings revealed that my focal ELL students took up and were ascribed a range of positions. Camila’s lack of verbal participation in the whole-group I-R-E resulted in the teacher’s positioning of her as a quiet student. She consistently positioned herself as agreeable and was positioned as a marginal discussion participant by female table members who were more dominant and assertive during table group discussions. Although her ideas were sometimes quickly dismissed within the group, she was never observed to hold on to her own ideas determinedly or to maintain the floor. Instead, she seemed comfortable to remain in the position as an agreeable student and participate marginally and focus on getting the final answer confirmed by the discussion leaders. At her table, she frequently asked for academic help from Sophie, who positioned herself as teacher by giving directives for Camila to follow.

With respect to fulfilling classroom behavior expectations, Lucas was often assigned the position as an uncooperative or unmotivated student by the teacher because of his habitual behaviors of zoning out during guided notes and avoiding assigned writing tasks such as writing down answers to the questions in a worksheet. Lucas actively participated in Jeopardy by asking table members for answers and suggesting answers to members when he thought he knew. However, his suggested answers were often ignored or corrected by members. Lucas was also sometimes accused by a neighboring table for stealing answers and thus negatively positioned as a competitor who cheats. During individual instructions on reading and writing tasks such as locating the source information, Ms. Reed often negated Lucas' answers, positioning him as incompetent, and took over the reading and writing task herself, positioning Lucas as non-reader or non-writer. The non-reader or non-writer position precluded Lucas' engagement with the assigned reading or writing task.

Felipe's cemented identity as an uncooperative student was evidenced by often receiving reprimands from the teacher for not sitting properly, paying attention, or following the teacher's instructions. He sometimes demonstrated resistance to the teacher's scolding by remaining silent and not following the teacher's directions immediately, which further led to the teacher's positioning of him as disrespectful. During Jeopardy, Felipe asked for help from Jay, who would give explanations of important terms in the questions, and Jay also offered help by whispering answers to Felipe when the teacher approached to ask Felipe a just announced Jeopardy question. Thus, Felipe's identity as a student who needs help was evidenced by both reflexive positioning and interactive positioning. Although Felipe tried to negotiate a competent student position by repeating his own answers, which were sometimes validated by Ms. Reed, to table members, he was not offered a place in the discussion and decision of group answers during Jeopardy. His difficulty to negotiate the competent student identity could also partly result from his inability to write complete words on his white board. Felipe demonstrated frustration and resistance to reading and writing tasks in science for which he was not offered adequate support. Although Jennie sometimes realized Felipe's need for help with some reading and writing tasks, she and other female table members pointed out what Felipe failed to complete rather than offering effective help. In addition, like Lucas, Felipe was negatively positioned as a nonwriter by the teacher's takeover of literacy tasks such as locating source information and identifying variables in his research question and writing them down in the packet. On one occasion, his small handwriting in Spanish in the procedure section of his science fair packet was neglected by Ms. Reed, who demanded that he type his experiment procedure in English in the slideshow for presentation. When his Spanish writing was noticed by his table members, he assumed the position of a competent Spanish user by pointing out their inaptitude in reading Spanish.

RQ 3: How do the focal ELLs perceive themselves as science learners?

My findings regarding focal ELLs' self-perceptions as science learners reveal the similar and different ways in which they affiliated with science and school and used their experiences of learning science at school and knowledge about science to express viewpoints about themselves as scientists and science learners. Camila associated the practices of sharing and teaching useful information, doing experiments, and dissecting animals with what scientists do. She perceived herself as a scientist when she delivered information about bacteria and gave her audience safety tips to keep bacteria away during the science fair. She also represented herself as a biological scientist doing the squid dissection in her drawing and explained how she carried out the dissection with her group members in a step-by-step fashion and that scientists use tools (e.g., gloves) to do something such as an experiment. Furthermore, her perceptions of scientists were fused with classroom expectations of being a good student (e.g., having "a good answer", doing the work), and she saw herself as a scientist because she did her work, was nice, and shared things with others. As for being a student, Camila described herself as a motivated learner who was interested in learning about multiple topics in the science class and deemed receiving education as important for doing small things such as watering a plant as well as having a job and a career. She also identified herself as a learner who transitioned from being confused to being successful and knowing a lot of scientific facts and a good student who complied with classroom behavioral norms such as listening, never talking over the teacher, and following instructions.

Lucas's drawings of scientists were derived from his imagination and movies he had watched. These drawings, along with Lucas' explanation, depicted scientists as using chemicals to invent a cure with the assistance from a future robot and as handling chemicals to figure out what kinds of chemicals made aliens' skin green. Lucas thought of himself like a scientist when he was doing the squid dissection and his squishy egg experiment. While Lucas identified both conducting dissections and doing experiments as practices that scientists engage in, he did not perceive himself as a scientist because he did not possess a lot of scientific knowledge. As for being a student, Lucas described himself as a tactile and visual learner who was excited about doing experiments in the science class, dissecting a squid, and visiting the science museum to see and play with "science stuff". Academically, Lucas admitted that he was not good at science. He thought Ms. Reed would probably think he was "Okay" and was hesitant when answering if his classmates would describe him as "smart". He identified himself as a less competent reader in science because finding facts from a text within a time limit and the large number of new words in readings were challenging for him. In addition, Lucas saw himself as a student who met classroom behavioral codes such as listening to and following the teacher's instructions and did his work most of the time. He also thought of himself as a helpful partner who helped his classmates by cutting the squid during the squid dissection and explaining how to plant seeds.

Similar to Lucas, Felipe did not see himself as a scientist, but he identified some of his experiences in the science classroom - doing the squid dissection, making a discovery during the squid dissection (i.e., the squid changed colors), measuring the weight of rocks with a scale, and setting up a display board with pictures of his experiment materials – as practices scientists engage in. Although his drawings of a scientist and himself as a scientist during the final interview revealed common elements (i.e., both pictures included a scale and a display board), Felipe demonstrated unsureness about the question if he was a scientist repeatedly. Apart from relating his experiences of doing science in the classroom to what scientists do, Felipe also mentioned additional practices that scientists participate in, including helping kids to learn science and using a device to study volcanoes. He did not view himself as a scientist because (1) he did not help kids like scientists and (2) what scientists do was more complicated than what the students and the teacher did in the classroom. With respect to being a science student, Felipe described himself as a compliant student who did what the teacher asked. However, he claimed that he was not sure if he was good at science and how Ms. Reed and his classmates would describe him as a student. He demonstrated interest and confidence in hands-on activities when he talked more extendedly about how he created his blowfish diorama with the help from his tío (uncle) and aunt and how he made an effort to put the wheels onto the Mars rover assembled by his table group and make sure they stayed. Additionally, Felipe recognized himself as a science learner receiving help from different teachers with multiple learning tasks, which included measuring the weight of rocks, writing the presentation speech, typing words into his slideshow, and developing the display board for his science fair project on porous rocks.

Discussion

In this section, I first interpret the connections between findings from the three research questions that guided this study. Findings from RQ 2 reveal the different ways in which the focal students took up or resisted the celebrated practices addressed by RQ 1 within their interactions with the peers and the teacher, as well as what kinds of positions they were able to assume or be assigned when they took up or resisted the celebrated practices. The connections between RQ 1 and RQ 2 findings will be further discussed in a following subsection section where I talk about how this study adds to science identity research that examines the structure-agency dialectic.

I argue that RQ 3 findings relate to RQ 1 findings in two ways. First, the range of celebrated practices in this fourth-grade science classroom shaped the case study students' perceptions of themselves as science students and as scientists and what scientists do. All the focal ELLs associated the celebrated practices, such as listening and following the teacher's instructions, with their self-perception as a good science student. While Camila associated being a successful learner with knowing and remembering many science facts, Lucas distinguished himself from scientists due to his lack of possession of scientific knowledge. Additionally, Camila even infused the celebrated practice of having a good answer or explanation into her perception of what scientists do. Second, the focal students' self-perceptions as science learners reveal that for them, doing science and what they loved about science encompassed more than the celebrated practices in the classroom. During the two-month period of data collection, Felipe and Lucas were not given multiple opportunities to engage in hands-on explorations which they loved. Though they had the chance to conduct experiments for their own science fair projects, they mostly engaged in science learning by listening to lectures, answering closed-ended questions, and writing notes. As for Camila, other than her science fair project presentation on bacteria, she was not provided with multiple opportunities to share her understanding and knowledge about a certain science topic. However, sharing useful information comprised an important part of her self-perception as a scientist.

Contribution to Science Identity Research

Identity as constituted and reconstituted in discourse. This study supports and extends the increased body of research that uses practice theory to study students' development of science-related identities. These studies assume that the cultural meanings of doing science and the preferred/celebrated science student identity are produced in everyday practices in the science classroom and highlight the structure-agency dialectic by illuminating how students conform, resist, negotiate, or transform these meanings (e.g., Buxton, 2005; Calabrese Barton & Tan, 2010; Carlone, 2003; Carlone et al., 2014). Using ethnographic analysis of classroom observational data, findings from Research Question 1 in my study identified the celebrated and marginal practices within common classroom procedures, thus shedding light on the group-level meanings of "good science student" in this particular fourth-grade science classroom which were tied to complying with classroom behavioral codes, having/telling the right answer, and following the teacher's directions. Findings from my Research Question 2, which were based on the documentation and micro-analysis of focal ELL students' behaviors and discursive practices in various classroom interactions, suggest the structure-agency dialectic discussed by previous research. In other words, my findings demonstrate that the case study students' agency was guided and constrained by the produced meaning of "good science student" in the classroom. For example, Camila remained in the agreeable student position and actively took on the position of student who needs help during table group discussions, suggesting that she conformed with the celebrated practice of having the right answer associated with the "good science student" identity. Felipe's refusal to take notes as directed and resistance to doing an assigned literacy task as well as Lucas' lack of attention in class and engagement in unproductive activities such as tying shoelaces led to the teacher's and the peers' recognition of them as uncooperative students.

While previous studies predominantly researched students' take-up, resistance or negotiation of the cultural meanings of doing science and celebrated subject positions through analysis of student interview data (e.g., Buxton, 2005; Carlone, 2004; Olitsky, 2006) and student-produced artifacts (e.g., Calabrese Barton & Tan, 2010), my study sheds light on students' difficulty with the negotiation of a "good science student' identity, as well as the risks they are taking, through micro-analysis of their interactions within the science classroom. For example, both Felipe and Lucas actively participated in table group conversations during Jeopardy by actively suggesting their answers to announced questions to table members and seeking the teacher's approval for their answers, indicating that both students conformed with the celebrated practice of telling the right answer. However, their proposed answers were ignored by their peers, and for Felipe, even if his proposed answers were legitimized by the teacher, his table members seldom positioned him as a competent student. While Camila took up the celebrated practice of having the right answer by constantly asking for the answer from more dominant table members, she was positioned as a marginal discussion participant at her table, losing the opportunity to engage more meaningfully through speaking and defending her thoughts or engaging in disagreement with her peers. For all my focal students, the celebrated "good science student" identity seemed inaccessible.

My study supports the argument that both the students and the teacher contribute to the creation and sustaining of cultural meanings through participating in cultural practices (e.g., Buxton, 2005; Carlone & Johnson, 2012). However, my study suggests that the students' compliance with the group-level meanings of the celebrated science student identity could jeopardize individuals' participation in opportunities for learning. For example, my findings show that Felipe was never observed to ask for or receive effective academic help from his new table members after the spring break. Although the teacher expected and explicitly told Jennie to help Felipe when he had difficulty with doing online background research or completing writing tasks in his science fair planning packet, Jennie and other female members pointed out what Felipe failed to accomplish and reprimanded his off-task behaviors. Their reprimands for Felipe sustained the group-level meaning of "good science student" as meeting classroom behavior expectations and following the teacher's instructions to complete tasks. Perhaps, their negative positioning of Felipe as an uncooperative student led to their refusal to offer help and Felipe's reluctance to voice his need for academic help.

Along with research that argues for the importance of access to linguistic resources for ELLs to gain legitimate membership within an English dominant classroom (e.g., Gamez & Parker, 2018; Iddings, 2005; Norton & Toohey, 2001), my findings suggest that the English-only policy within the classroom could lead to negative positioning of ELLs, especially for newcomer students with emergent English language proficiency such as Felipe. The English-only policy was evidenced and reinforced by Ms. Reed's requirement for Felipe to write English. In addition, she seemed to take a deficiency view towards Felipe's tiny handwriting in Spanish by not seeking to understand what he had written down. The non-writer position she assigned precluded Felipe from engaging meaningfully by using Spanish as a legitimate resource and having opportunities to develop language and literacy skills in science.

Students' self-perception as science learners. This study adds to the knowledge base of research that sheds light on the sophisticated ways in which students perceive themselves in relation to science, scientists, and their peers and teacher in the science classroom. My findings regarding Camila's construction of herself and her friends in relation to scientists reveal that she combined norms of "doing school" (e.g., having good answers to the teacher's questions, doing one's work, being nice to others, and sharing things) into ways of being a scientist, which corresponds with the results from previous research that reported how students' conception of "doing science" was blended with behavioral norms of "doing school" (Varelas et al., 2011; Zhai et al., 2013). Interestingly, Camila was the only case study who conflated norms of "doing school" with "being a scientist", as the other two students Felipe and Lucas did not relate "doing school" with "doing science" in this manner. Though my findings were based on a very small sample size, Camila's conflation of "doing school" with "doing science" could be alarming. As Varelas et al. (2011) pointed out, the emphasis on regulatory behavioral norms communicated to children signals a *pedagogy of control* which "may lead to compliance that is so contrary to the stance of science as inquiry, as exploration, as "thinking out of the box" that educators may celebrate and strive for" (p. 834). Furthermore, my findings suggest that all the case study students used meeting the classroom behavioral expectations as a criterion for judging whether they were good students. Zhai et al. (2013) argued that such a disposition by students could result from the teacher's focus on students' good behavior and the authoritative role of the teacher in students' learning of science.

My findings suggest that Lucas and Felipe did not include literacy dimensions as a significant part within their perceptions of themselves as scientists. While both students emphasized hands-on explorations such as conducting the squid dissection and doing experiments as scientific practices, they did not give details about how they did background research for respective science fair projects, how they developed their research questions and experiment procedures, or how they recorded their data observations during experiments, nor did they associated these reading and writing practices with the construction of themselves being scientists. In contrast, the young African American students in Varelas et al. (2011) saw themselves as scientists as they engaged in writing, drawing in journals, and reading. Varelas and her colleagues suggested that the students included these literacy dimensions as salient features of doing science because these were the areas that their teachers would say that they were competent in. Thus, students' representation of themselves as scientists were likely to "intertwine their asserted, actual competencies, preferences, and ways of making sense of their experiences, and their assigned, designated, encouraged ones by other people in their lives, such as teachers, family members, and peers" (p. 839). Among the possibly many reasons for the contrast in the findings between my study and Varelas et al.'s, one may be that reading and writing in science were not areas in which Felipe and Lucas thought they excelled. Based on the classroom observational data as well as Felipe's own account during the final interview, he received a significant amount of assistance from Ms. Reed and others with doing background research, identifying source information from websites, creating the slideshow, and putting together a display board for his science fair project. Lucas identified himself as an unconfident reader in the science class and was observed to receive help from Ms. Reed and Kevin with identifying source information and typing in the slideshow his research question and experiment procedures.

My study complements previous research that has examined students' lack of identification with science and scientists. Zhai et al. (2013) found that some students stated that they were unlike scientists because scientists work with dangerous experiments and do not need to listen to the teacher and complete the workbook. DeWitt (2013) showed that narrow constructions of scientists as 'specialist' and 'clever' may contribute to an understanding of science as 'not for me' and discourage young people from pursuing science qualifications and careers. Archer et al. (2010) revealed that though most of the ten-or-eleven-year-old students in their study enjoyed science, they did not choose to study it at higher level and found a science identity undesirable due to the dominant gendered, raced, and classed configuration associated with it. However, my data reveal different reasons why Lucas and Felipe showed hesitancy about whether they were scientists. Lucas associated the possession of a high level of knowledge with scientists but claimed that he did not know that much science and thus was not a scientist. Felipe made a clear distinction between school science and “real” science by stating that what scientists do was more complicated than what the students and the teacher did in the science classroom. Another reason for Felipe’s refusal and hesitancy to identify himself as a scientist was that he did not help kids learn as scientists.

Finally, my finding regarding Camila’s perceptions of herself as a scientist suggests that science for her was an enabling subject. Camila showed confidence and enthusiasm about sharing with people her research about bacteria during the science fair and giving them advice to keep bacteria away, and these aspects made up a significant part of her scientist identity. Consistent with what Varelas et al. (2011) has found, my data about Camila reveal that she may consider knowledge as an asset; that is, for Camila, the possession of expert knowledge, as a form of cultural capital (Bourdieu, 1986), enables people to provide that knowledge to others.

Contributions to Practice

This study contributes to the understanding of how the meanings of “doing science” are created within common classroom procedures in a given science classroom. Science teachers should be aware if the range of celebrated practices within their classrooms are narrow and if these celebrated practices are accessible to all students. As prior scholars have proposed, equitable science classrooms should expand the subject positions afforded to students, provide opportunities for students to negotiate participation and share authority, and foster a sense of agency and ownership (Calabrese Barton & Tan, 2010; Carlone et al., 2011; O'Neill, 2010). Based on my findings about focal ELLs' participation and interactions in their science class, I argue that narrowly defined ways of "doing science", such as telling the right answer, constrain the range of opportunities for students to demonstrate competence and engage meaningfully in classroom activities. For example, both Felipe and Lucas struggled with positioning themselves as competent during Jeopardy when proposing answers to their table members, and Camila was positioned as a marginal discussion participant during table group discussions and oriented herself to getting the answer rather than actively expressing her ideas.

Second, Camila's focus on getting the right answer during table group discussions suggests how what students are held accountable for in a small group activity or the purpose of the activity could potentially affect students' ways of participation in it and their positioning. In Ms. Reed's science classroom, few opportunities were provided for students to engage in small group discussions, and the purposes of student discussions seemed narrow and concentrated on collectively deciding the group answers to questions on a worksheet and helping each other to get answers. Additionally, Ms. Reed's evaluation of the students' participation during table group discussions focused on whether they got the right answer (i.e., when she approached Camila's table to check her answers in the packet, she commented, "Excellent work you guys. Excellent work."). Thus, I argue that to engage quiet ELL students such as Camila in small group discussions, science teachers should expand the purposes of student discussions beyond collectively determining the group answers to assigned questions and monitor small group discussions and intervene to make sure all students within a group take turns and contribute. Furthermore, to make small group settings as an equitable space that all students, including ELLs, could participate meaningfully, teachers should recognize talk as a means for learning and meaning making. This is consistent with Mercer et al.'s (2004) consideration that science teachers should develop children's awareness and skill in using talk as a means for problem-solving and developing their scientific understanding.

Third, this study highlights the need for science teachers to align what students are accountable for with the support provided. My data show that merely giving directions for Felipe to follow (e.g., develop and write down a search question that had to do with rocks) and not providing effective linguistic scaffolding contributed to his frustration and resistance to assigned literacy tasks. Thus, I argue that science teachers should not only have explicit literacy goals for each lesson but also provide linguistic scaffolding to develop ELLs' scientific discourse skills necessary for meeting the literacy goals, such as clarifying the vocabulary and sentence structures needed to form a research question. In addition, my findings demonstrate that providing assistance for Lucas and Felipe by taking over the literacy tasks such as locating source information from a website and developing step-by-step experiment procedures positioned the students as incompetent and deprived them of opportunities to engage in the tasks meaningfully by contributing their own intellectual resources. Therefore, I argue that to avoid negative positioning of ELL students and enable them to participate in learning meaningfully, teachers should adopt a dialogic approach to individual instructions with ELLs in which “speakers build on each other’s contributions, add information of their own and in a mutually supportive, uncritical way construct shared knowledge and understanding” (Mercer, 2000, p. 31).

Third, this study calls attention to the need for teachers to provide heritage language support in the science classroom. In the State of Arizona, the segregation of ELLs from the mainstream population and their limited access to the content curriculum based on the state’s educational language policies have raised concerns among scholars (e.g., Gandara & Hopkins, 2010; Iddings et al., 2012; Lillie & Moore, 2014). Although the focal ELLs in my study were able to receive science instruction with the mainstream population, Ms. Reed’s requirement for Felipe to write in English and neglect of his written Spanish invalidated the use of his heritage language and precluded him from engaging in the science curriculum meaningfully and productively. For science teachers like Ms. Reed who are not proficient in ELLs’ heritage language, legitimizing students’ heritage language as a resource that facilitates their access to the science curriculum and participation in learning could be challenging. However, teachers should realize that though ELLs’ L1 can be difficult for them to comprehend, language is a tool and a resource for meaning making. Effective support can still be offered through collaborating with other teachers with linguistic proficiency in ELLs’ heritage language within the school (such as the focal ELLs’ home classroom teacher Mrs. Bain) to provide translation of instructional materials, giving permission to use the heritage language for learning, allowing ELLs to offer translation help between each other, and so forth.

Lastly, this study suggests that the way science is taught is likely to influence students’ conception of what “doing science” means. While Camila indicated in the final interview that the purpose for scientists to do a science project is to answer a question, Felipe and Lucas seemed to attach “doing science” to hands-on practices such as doing experiments and conducting dissections. While this difference in ELLs’ conception might indicate Felipe’s and Lucas’s struggle with developing the research question for their respective science fair project or their lack of understanding about the purpose of conducting an experiment, it could also suggest the need for science teachers to clarify and emphasize with students what purposes experiments serve and to engage students intellectually. As Driver, Newton, and Osborne (2000) emphasize, “Observation and experiment are not the bedrock on which science is built, but rather they are the handmaidens to the rational activity of generating arguments in support of knowledge claims” (p. 297).

Limitations

This study is limited in two major ways. First, due to the limited scope of this study in terms of time (i.e., data observation lasted for two months), it is not able to trace the focal ELLs’ identity trajectories through an entire school year as other longitudinal studies. However, within such a short duration of data observation, it has been my hope that this study could shed light on the focal ELLs’ experiences and positioning across various learning contexts – such as Jeopardy, table group discussions, independent work, and individual instructions – within the science classroom.

Second, given the case study design (Merriam, 1998), findings from this study cannot be used to make sweeping generalizations about the science learning experiences and identity formation of elementary ELLs. I explored ELLs’ performed identities and perceptions about themselves as science learners in a particular fourth-grade science classroom, and due to the diversity of science classrooms with regard to science teachers, instruction approaches, language policy, etc., my findings are not applicable to other ELLs in other classroom contexts.

Implications for Future Research

My micro-analysis of focal ELLs' positioning in classroom language and literacy events reveals how they took up or resisted the celebrated practices within a particular elementary science classroom and how accessible the "good science student" identity was for each of them. As this dissertation was conducted in a teacher-centered science classroom in which the meanings of "doing science" and the celebrated science student identity were narrowly defined, new research on ELLs' development of science-related identities needs to be conducted in more equitable science classrooms that encourage student inquiry and broadly define the celebrated science student identity. This kind of research could benefit from using a microethnographic discourse analysis perspective (Bloome et al., 2005) or other discourse analysis approaches to examine on a moment-by-moment basis how ELL students negotiate their positionings and participation, the ways in which the circulating understandings of "doing science" may mediate interactions and positionings, and whether the broadened celebrated science student positions are available for ELLs.

Second, my study reveals that the English-only policy within the classroom, along with the inadequacy of language and literacy scaffolding, led to negative positioning of Felipe, a newcomer student with emergent English language proficiency. This finding indicates that more research is needed to address what kind of challenges science teachers face to support newcomer students in the English dominant classroom and how science teachers, with limited linguistic proficiency in the ELLs' heritage languages, can effectively support ELLs' development of language and literacy skills in the subject and their development of positive academic identities. For example, Pacheco (2016) began to address the forms and functions of translanguaging in two English-centric literacy classrooms and a variety of factors that afforded and constrained translanguaging practices for meaning-making. One area of productive research could be to examine ELLs' emerging science-related identities when science teachers in the English dominant classrooms introduce translanguaging practices into teaching and begin to incorporate students' heritage languages as resources.

Third, my analysis of focal ELLs' positioning within their own table groups suggests that peer interaction is an important site for ELLs' negotiation of science-related identities. All the focal students experienced negative positioning by their peers to different degrees and for different reasons, and these positions ranged from marginal discussion participant to uncooperative or incompetent student. I argue that more work is needed to investigate how science teachers could design small group activities that promote participation and collaboration among all group members and how teachers could effectively intervene to engage ELLs in group discussions and collaborations, making small group settings an equitable learning environment for ELLs. Furthermore, science teachers could also benefit from research that looks into how group members could influence ELLs' learning and development of science-related identities. For example, Gamez and Parker (2018) investigated how ELLs' peers improved their engagement with science through the use of language brokering and code switching, which mediated the identities that ELLs could author within the science classroom.

Lastly, this study shows the value of researching the nuanced and different ways in which ELLs perceive themselves as science students. Through their own narrations, my focal ELLs revealed what they were enthusiastic about in science, areas that they felt confident in, their motivations for learning science, their understandings of what it meant to be a good science student and to be a scientist, what roles their peers, teachers, and parents played in their learning of science, etc. These stories, I believe, need to be shared with science teachers so that they could reflect upon and improve their own teaching. Thus, further research needs to take into account ELLs' experiences of learning science and their own voice and perspectives on science.

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APPENDIX A

ELLS' SELF-PERCEPTION AS SCIENCE LEARNERS

Part 1: Yourself as a scientist

1. What do you think scientists do?
2. Are you a scientist? Why do you think so?
3. Where do you do/learn science (e.g., inside the classroom, outside the classroom, at home)?
4. Can you think of a time when you were a scientist? Can you describe what it was like?
5. Who is a scientist among the people around you (e.g., your family, your friends, your classmates)?
6. What makes him/her a scientist?
7. *Do you see yourself differently as a scientist now? Why?

Part 2: Yourself as a science student

1. How do you feel about school?
2. What are you good at in school?
3. How do you feel about Mr. XXX/Mrs. XXX's class? Why?
4. If you are going to tell a new student what it is like to learn science in Mr. XXX/Mrs. XXX's classroom, what would you say?
5. What are you good at in Mr. XXX/Mrs. XXX's class?
6. What are you good at in science?
7. How would you describe yourself as a student in Mr. XXX/Mrs. XXX's class?
8. What are you excited about learning science in Mr. XXX/Mrs. XXX's class?
9. Can you describe one time when you were excited about learning science?
10. What is challenging about learning science?

11. *What is the project/assignment that you feel proud of so far? Why?
12. *Can you describe one time when you struggled with learning science?
13. *Who is a good science student in Mr. XXX/Mrs. XXX's classroom?
14. *What makes him/her a good science student?
15. *Who would you choose as your partner(s) for a science project? Why?
16. *Can you describe the last time you worked with your group members on a science project?
17. *How did you work with your group members?
18. *Did your group members work well? How?
19. *What do you think your group members would say about you as a partner?
20. *How do you think about your group project?
21. *Has your opinion about yourself as a science student changed? Why and how?

Note: the questions marked with the asterisk will be asked the second time and the third time when the interview protocol is conducted, as it is possible that students may not have collaborated with others on science projects at the beginning of my data collection. As Question #7 in Part 1 and Question #21 in Part 2 deal with changes in students' perception of themselves as scientists and as science students, it makes more sense if I ask such a question after they've learned one science unit and near the end of my data collection.

APPENDIX B

TRANSCRIPTION CONVENTIONS

(5.0)	Pause of 5 seconds
/	Speaker self-repairs or restarts
::::	Elongated sound in the middle or end of word
=	Turns before and after are latched together
( )	Items within describe nonverbal behavior
[ ]	Items within are clarifications added by the researcher
“ ”	Items within are quoted speech
// //	Items within overlap with another speaker’s speech
[	A left bracket indicated the point of overlap onset.
]	A right bracket indicates the point at which two overlapping utterances end, if they end simultaneously, or the point at which one of them ends in the course of the other.
LOUD	Capitalized words said loudly
Introduced	Italics words are English translation of Spanish
XXX	XXX indicate that the researcher was unable to get what was said.

APPENDIX C

THE UNIVERSITY HUMAN SUBJECT INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL

EXEMPTION GRANTED

Lindsey Moses
Division of Teacher Preparation - Tempe
-
Lindsey.Moses.1@asu.edu

Dear Lindsey Moses:

On 10/25/2018 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Science Identity Development of Elementary English Language Learners in a Mainstream Science Classroom
Investigator:	Lindsey Moses
IRB ID:	STUDY00009096
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Qiao-Parental Permission (updated2).pdf, Category: Consent Form; • Current Progress-10.24.18.pdf, Category: Other (to reflect anything not captured above); • Qiao-Assent.pdf, Category: Consent Form; • Qiao-IRB-dissertation (updated1).docx, Category: IRB Protocol; • IRB exempt wizard completion.pdf, Category: Other (to reflect anything not captured above); • Qiao-Teacher Consent (updated1).pdf, Category: Consent Form; • Qiao_Invitation to Participate_09142018.pdf, Category: Recruitment Materials; • interview protocols-ELL science identity-dissertation.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (1) Educational settings on 10/25/2018.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Xue Qiao
Xue Qiao