TEACHING CONTENT STANDARDS TO ENGLISH LANGUAGE LEARNERS

Elementary Science Teachers' Use of Language Development and Home Language Strategies

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The language demands implicit in the Common Core State Standards and Next Generation Science Standards present both challenges and opportunities for English language learners (ELLs) (Lee, Quinn, & Valdés, 2013). Given the critical role that content area teachers will play in the implementation of these standards, this study investigated the extent to which elementary science teachers report using language development and home language strategies when they teach science to all students, especially ELLs. One hundred and fifteen fifth-grade science teachers completed a questionnaire at the end of the school year. A majority of teachers reported using language development strategies in their science teaching during most or all of their lessons. Still more encouraging, we found evidence that teachers may be particularly sensitive to the needs of ELLs, as teachers with ELLs and former ELLs in their classroom reported more frequent use of these strategies. In addition, many science teachers with ELLs and former ELLs in their classrooms reported incorporating their students' home language in their teaching.

Keywords: Common Core State Standards (CCSS), English language learners, home language strategies, language development strategies, Next Generation Science Standards (NGSS), science instruction

Among the most striking recent demographic trends in U.S. K–12 education has been an astonishing rise in the proportion of students identified as English language learners (ELLs). In the past two decades alone, enrollment of ELLs at the national level "has increased at nearly seven times the rate of total student enrollment" (Pompa & Hakuta, 2012, p. 123). Accompanying these demographic shifts has been the widespread adoption of new standards—the Common Core State Standards (CCSS) for English Language Arts and Mathematics and the Next Generation Science Standards (NGSS), national initiatives that aim to improve educational outcomes through more rigorous, better integrated content knowledge and language/literacy development. For decades, applied linguists and language educators have discussed instruction that integrates content and language in the context of language immersion education (e.g., Genesee, 1987) and content-based instruction (e.g., Brinton, Snow, & Wesche, 1989), among others. This conversation, however, is relatively new to the larger field of K–12 education. Traditionally, K–12 teachers have not been tasked with helping their ELLs acquire English and learn content at the same time. And yet, given the unprecedented growth of the ELL population, coupled with

both the content and language demands inherent in the CCSS and NGSS, the responsibility for both the content and language learning of all students, including ELLs, will soon fall to all teachers.

Clearly, if these ambitious standards for the integration of language and content teaching are to succeed, content area teachers, such as those who teach science, will likely require additional training to effectively "support the deeper content, performance and language demands expected of [their] students" (Santos, Darling-Hammond, & Cheuk, 2012, p. 106). Moreover, the success of such training will depend on the extent to which its design is informed by (a) theoretical and empirical research on effective science content instruction for ELLs, and (b) a more precise, data-driven understanding of science teachers' current practices with respect to ELLs.

Best Practices in Science Instruction for ELLs

In her review of research on science content instruction for ELLs, Janzen (2008) synthesized a wide range of best practices that researchers have identified in the domains of general pedagogy, linguistic and sociocultural issues, and teacher education/professional development. She concluded that "science teachers must not only be familiar with science content and how that content is constructed linguistically, but also familiar with the cultural practices and 'ways of knowing' espoused by different groups of students" (p. 1029). In addition, she underscored the importance of teachers "see[ing] value in these differing practices . . . demonstrat[ing] their respect for them in meaningful ways in a classroom setting . . ." and being "aware of instructional approaches that can effectively engage all students in 'doing' science rather than simply memorizing facts" (p. 1029).

Comprehensive reviews of effective instructional strategies for ELLs by Lee (2005) and Buxton and Lee (2014) underscored the critical importance of the latter point, suggesting that approaches marrying student-centered, hands-on, inquiry-based instruction with targeted academic language and literacy development can grant ELLs meaningful access to science content while simultaneously "promot[ing] scientific discourse and . . . English language proficiency" (Lee, 2005, p. 505). A number of instructional strategies have been found to be central to such an approach, including: (a) presenting science content through a variety of channels and (in particular, graphic) formats; (b) consciously and continuously modifying oral classroom discourse to ensure comprehension of students at varying levels of proficiency; and (c) drawing on meaningful artifacts or realia to concretize otherwise abstract scientific concepts (Buxton & Lee, 2014). A growing number of quasi-experimental and experimental studies have found evidence that interventions incorporating these strategies result in a positive impact on elementary students' science achievement (e.g., August, Branum-Martin, Hagan, & Francis, 2009; Lara-Alecio et al., 2012; Maerten-Rivera, Ahn, Lanier, Diaz, & Lee, in press; Zwiep & Straits, 2013).

The value of ELLs' home language "as an instructional support to enhance science learning" has also figured more prominently in recent literature (Buxton & Lee, 2014, p. 209). While some science education researchers have broached in a more cautionary tone the topic of home language use (Lynch, 1996a, 1996b), others have openly advocated for a greater presence of the home language in science content instruction for ELLs (Kearsey & Turner, 1999), with mounting evidence that native language proficiency (Guglielmi, 2012) and home language use in the classroom (Turnbull, Cormier, & Bourque, 2011) are associated with not only English literacy development but also science achievement for some ethnolinguistic groups. Furthermore, to illustrate the broad applicability of home language use in the science classroom, Buxton & Lee (2014) distinguished between home language instruction (i.e., a language other than English as the language of instruction) and home language support, whereby all science teachers—including those who are not proficient in their students' home language—can foster a linguistically supportive learning environment by encouraging students to draw on their home language (either independently or with peers) as a resource for science learning.

Current Teacher Practices in Science Instruction for ELLs

As noted earlier, ensuring an adequately prepared teaching force in the wake of new, language-intensive content standards will require a clear, reliable sense of where current science teachers are right now—that is, we need to know more about science teachers' current inventory of instructional practices and how often they incorporate language-related strategies for ELLs. With the exception of studies that examine the impact of a specific intervention on teachers, few empirical studies have explicitly documented content area teachers' practices and/or beliefs related to the teaching of content to ELLs in the absence of an intervention. Only a small number of studies have surveyed content teachers' use of language-related instructional practices at the middle school and high school levels (Barrera, Shyyan, Liu, & Thurlow, 2008; Cho & McDonnough, 2009; Thurlow, Albus, Shyyan, Liu, & Barrera, 2004), and the empirical literature on science teacher practices and beliefs with respect to ELLs at the elementary school level is also rather limited.

A notable exception is the work of Lee and colleagues on language development-focused curricular interventions for elementary school science teachers with ELLs. Lee, Maerten-Rivera, Buxton, Penfield, and Secada (2009) described science teachers' reported support for English language development as a part of a study of urban elementary teachers' knowledge and practices in teaching science to ELLs. Two hundred and twenty-one third, fourth, and fifth grade teachers in 15 schools completed a questionnaire about their use of a range of language-related teaching practices (e.g., purposefully create small groups of English proficient and ESOL students to work together in science class). The results of the study indicated that teachers reported using the focal strategies to promote English language development in only some of the science lessons. The study also revealed that teachers reported using home language strategies in comparatively fewer lessons. An earlier and smaller study by Lee, Lewis, Adamson, Maerten-Rivera, and Secada (2008) also examined science teachers' support for English language development. In addition to data based on the same questionnaire, this study included interview and observation data with 38 third-grade teachers in an urban school district with a diverse student population. Teachers reported using language development or home language strategies to promote English language development in only some of the science lessons. Classroom observations, however, revealed that teachers actually used language development strategies more often than reported. Nonetheless, the authors explained that teachers' use of strategies still fell short of national reform standards. It is important to note that in both studies (Lee et al., 2008, 2009), around 85% of the teachers had an ESOL degree or endorsement. Also, in both studies a number of teachers identified as native speakers of languages commonly spoken by their ELLs, with Spanish or Haitian Creole reported as a native language by 15% of teachers in Lee et al. (2008) and 33% of teachers in Lee et al. (2009).

The results of Lee et al. (2008, 2009) provide valuable data on the prevalence of language development and home language strategies as reported by elementary science teachers with high proportions of ELLs in their classrooms. Though clearly an important point of departure, at least two unanswered questions merit further exploration, particularly in light of the CCSS and NGSS. First, if science teachers with high proportions of ELLs are reporting having adopted some language development and home language strategies in their classrooms, what about their counterparts with fewer ELLs? Second, on a related note, if the new, language-intensive CCSS and NGSS are expected to apply to all students—including non-ELLs—are the language development strategies currently found among the practices of science teachers with no ELLs? If so, how frequent is their deployment of these strategies relative to colleagues who do have ELLs in their classrooms?

One study has attempted to systematically investigate the extent to which science content teachers differentially employ language development strategies with their ELLs versus their non-ELLs. Martinez, Bailey, Kerr, Huang, and Beauregard (2010) administered a survey to 53 fourth-grade science teachers from California and Colorado and conducted a series of two one-hour in-class observations for a subset of five teachers. Though the principal objective of the study was to pilot an assessment instrument

designed to measure students' opportunity to learn (OTL) and academic language exposure, the results of this work also shed some light on the extent to which science teachers varied their instructional strategies for their ELLs versus non-ELLs. The results of the survey suggested that teachers reported adopting "nearly identical" patterns of teaching with respect to language development strategies for both ELLs and non-ELLs, with two discernible exceptions. First, they reported providing their ELLs significantly more one-on-one instruction than for their non-ELLs. Second, they reported significantly more lenient practices of evaluation for their ELLs as compared to non-ELLs. These reported results seem to indicate that, while the teachers claimed to teach all their students in more or less the same way, they held their ELLs significantly less accountable for "understanding of scientific concepts, use of scientific vocabulary, knowledge of scientific facts, and progress relative to class" (p. 10). Another important finding from the survey was that the majority of the teachers—over 80%—acknowledged that their ELLs' home language was not typically incorporated as a language of instruction.

The Current Study

The study presented in this article builds on and extends the work of Lee et al. (2008, 2009) and Martinez et al. (2010) by investigating the extent to which elementary science teachers from three geographically and demographically distinct school districts in one state reported using language development strategies in their science instruction. This study also examined whether teachers' reported use of language development strategies was measurably different between those who had ELLs in their classrooms and those who did not. This method of comparison differs from that presented in the Martinez et al. (2010) study, where analyses focused on teacher practices as they varied for ELLs and non-ELLs within the same classrooms. This study also differs in that it examines reported teacher practices with ELLs and former ELLs. Again, it is crucial to understand how and to what extent the practices of science teachers with non-ELLs differ from those with ELLs and former ELLs, given that the CCSS and NGSS are language-intensive for all students. At the same time, the ELL population is increasing and more content teachers will begin to encounter ELLs and former ELLs in their classrooms. Thus, the current study investigated science teachers' reported use of language development strategies across a large number of science teachers, some of whom had ELLs and former ELLs in the classroom and some who did not. In addition, the present study examined how frequently science teachers who had ELLs and former ELLs in their classrooms reported incorporating their students' home language in their science instruction. Specifically, the study addressed the following research questions:

1. How often do science teachers report implementing language development strategies in their science classes? To what extent does teachers' reported use of language development strategies vary depending on whether or not they have ELLs and former ELLs in their classrooms?
2. How often do science teachers with ELLs and former ELLs report incorporating their students' home language in their science classes?

Method

Data for this study were drawn from a larger study of a curricular and professional development intervention designed to improve the science achievement of all students, especially ELLs (Lee & Llosa, 2011–2015). The research took place in three school districts in a southeastern state in the United States. These three school districts represented racially, ethnically, linguistically, and socioeconomically diverse student populations in varied educational settings and geographic locations. Science instruction in these districts was aligned to the state-developed science standards, which consist of 18 "big ideas" according to four bodies of knowledge—the nature of science, Earth and space science, life science, and physical science.[1]

Teacher Participants

A total of 115 fifth-grade science teachers from 33 randomly selected schools (three districts, 11 in each district) participated. Of the 115 teachers in the study, 36 had only non-ELLs in their classrooms and 79 had at least one ELL or former ELL. The demographic and professional backgrounds of the teachers are presented in Tables 1 and 2. "ELLs" refers to students who received services through English for speakers of other languages (ESOL) programs; "former ELLs" refers to students who had exited ESOL services within two years; and "non-ELLs" included students who had exited ESOL services over two years ago or were never in ESOL.

Table 1
Teacher Background Characteristics (Categorical Variables)

Variable	Teachers (%) (n = 115)
Demographic background	
Gender	
Female	85
Male	15
Ethnicity	
White, non-Hispanic	74
Black, non-Hispanic	13
Hispanic or Latino	12
Asian	1
Native language*	
English	96
Spanish	8
Other fluent language*	
English	4
Spanish	2
Professional background	
Highest degree	
Bachelor's degree	61
Master's degree or higher	39
ESOL training*	
Met ESOL requirement through college coursework	22
Met ESOL requirement through school district (META)	64
Completed bachelor's or master's degree in ESOL	6
Other	9
No ESOL training	4

*Teachers could select more than one response.

Table 2
Teacher Background Characteristics (Continuous Variables)

Variable	*M*	*SD*
Years of teaching	13.2	9.23
Years of teaching science	10.9	7.81
Science courses	2.6	2.61
Science methods courses	1.6	1.66

At the time of this study, nearly all participating teachers (96%) had earned some form of ESOL endorsement, a reflection of a state policy requiring all teachers to be professionally trained to work with ELLs. As for their general education, the majority of the teachers (61%) identified a bachelor's degree as their highest earned degree, though many had also completed a master's degree (39%). With respect to teaching experience, our sample of teachers had spent an average of 13 years in the classroom prior to the start of this study. The teachers were predominantly female (85%), white (74%), and native speakers of English (96%).

Teacher Questionnaire

The teachers completed a questionnaire for 30–45 minutes at the end of the 2012–13 school year. The questionnaire asked for teachers' demographic and professional backgrounds, and measured teachers' self-reported science knowledge and teaching practices in five domains. Three of the domains were science-specific, and two focused on language: (a) teaching practices to support students' language development, and (b) teaching practices to support the use of students' home language.

The two scales measuring teachers' language-related practices—language development strategies and home language strategies—asked them to rate the frequency of practices using a 4-point rating system (1 = never or almost never; 2 = some lessons; 3 = most lessons; 4 = every lesson). The five items that constitute the Language Development Strategies scale and the four items that constitute the Home Language Strategies scale are presented in the Appendix.

Data Analysis

Descriptive statistics were computed for each item in the questionnaire to create tables that show the numbers and percentages of teachers who reported using a strategy never, during some lessons, most lessons, and every lesson. In addition, a scale score was computed for each of the two scales—language development strategies and home language strategies. The score for each scale was computed using the average of the responses to the items that the scale comprised. Use of the average item response, as opposed to the summated score, ensured that missing responses would not lead to a systematic negative bias of the scale scores. Internal consistency reliability estimates for the scale scores using Cronbach's alpha (α) were .66 for the Language Development Strategies scale and .81 for the Home Language Strategies scale.[2]

A series of independent samples *t*-tests were conducted to determine whether teachers' reported use of language development strategies varied depending on the composition of ELLs, former ELLs, and non-ELLs in their classrooms. We also conducted analyses of teachers' practices with respect to home language strategies, comparing the reported strategies of teachers with only one ELL versus teachers with two or more ELLs.

Findings

We present findings related to teachers' reported use of language development strategies, followed by findings related to their reported use of home language strategies during science teaching.

Language Development Strategies in Science Instruction

Table 3 presents teachers' responses to the individual items in the Language Development Strategies scale.

Table 3
*Teachers' Responses to the Items in the Language Development Strategy Scale (*n *=115)*

Item	Never (%)	Some (%)	Most/Every lesson (%)
Present information in multiple graphic formats (e.g., graphs, charts, photos, diagrams, models, etc.)		15	85
Use realia (including hands-on activities) to help students develop the academic language of science	1	28	71
Make science text comprehensible (e.g., underline important information, identify main ideas and details, make inferences, etc.)		15	85
Make science talk understandable (e.g., clearer enunciation, longer wait time)		7	93
Use science terms in various contexts (e.g., introduction, science investigation, writing, discussion, etc.)	1	15	84

Note: We combined "Most lessons" and "Every lesson" for this descriptive analysis.

A vast majority of the teachers (71%–93%) reported using the language development strategies during most or every lesson. Perhaps of most interest is that no teacher reported never presenting information in multiple graphic formats, making science text comprehensible, or making science talk understandable. Only one teacher reported never using realia or using science terms in various contexts.

To investigate whether there were differences in the reported use of language development strategies between teachers with different compositions of ELLs, former ELLs, and non-ELLs in their classrooms, we used the mean score for the Language Development Strategies scale. Table 4 shows the mean scale scores for teachers with different classroom compositions.

Table 4
Mean Scores on the Language Development Strategies Scale

Teachers with the following compositions	*n*	*M*	*SD*
Non-ELLs only	36	3.01	0.43
At least one ELL or former ELL	79	3.21	0.42
At least one ELL but no former ELLs	23	3.32	0.34

On average, teachers with at least one ELL or former ELL in their classroom reported using language development strategies more frequently (M = 3.21) than did teachers with only non-ELLs in their classrooms (M = 3.01). This difference was statistically significant: $t(113) = 2.34$; $p = .02$. When we compared teachers who had at least one ELL but no former ELLs (M = 3.32) against teachers with only non-ELLs (M = 3.01), the difference in the reported use of language development strategies was even more pronounced: $t(57) = 2.94$; $p = .005$.

Home Language Strategies in the Science Classroom

Table 5 the responses to each item in the Home Language Strategies scale.

Table 5
*Teachers' Responses to the Items in the Home Language Strategies Scale (*n = *79)*

Item	Never (%)	Some (%)	Most/Every lesson (%)
Encourage more English proficient students to assist less English proficient students in their home language	26	25	49
Allow students to discuss science using their home language	52	25	23
Introduce key science vocabulary terms in both their home language and English	61	25	14
Allow students to write about science ideas or experiments in their home language	63	23	14

Note: We combined "Most lessons" and "Every lesson" for this descriptive analysis.

As shown in Table 5, with the exception of one of the strategies, fewer than half of the teachers with ELLs and former ELLs reported using home language strategies in at least some of their lessons. The strategy teachers reported using most frequently was encouraging more English proficient students to assist less English proficient students in their home language. In addition, reported use of home language strategies was not found to differ between teachers with one ELL versus those with more than one ELL, $t(46) = 1.26$; $p = .21$.

Discussion

This study investigated the extent to which elementary science teachers in 33 schools across three school districts reported incorporating language development and home language strategies in their science teaching. The descriptive analyses revealed that most of the science teachers reported using language development strategies during most or all of their science lessons. One explanation for the frequent reported use of these strategies may be that in the state where the study was conducted, ESOL endorsement is required of all teachers. As a result, all of the teachers receive some training to work with ELLs, either via college coursework or through district-provided training. The fact that teachers with ELLs or former ELLs in their classrooms reported using these strategies even more frequently than did teachers who had only had non-ELLs in their classrooms is encouraging, suggesting that science teachers were particularly sensitive to the needs of ELLs and former ELLs.

The study also revealed that many science teachers with ELLs and former ELLs in their classrooms reported incorporating their students' home language in their science teaching. The most frequently reported strategy, "Encourage more English proficient students to assist less English proficient students in

their home language," is one that can easily be implemented by all teachers, including those not proficient in the students' home language. That said, the fact that 52%–63% of the teachers with ELLs and former ELLs in their classrooms reported never using three out of four home language strategies suggests that there is room for improvement, a finding that Martinez et al. (2010) also identified in their work with elementary science teachers with ELLs.

It is important to point out that the language development and home language strategies that are the focus of this study and are representative of current best practices in science instruction for ELLs are primarily meant to facilitate student access to and comprehension of science content. As instruction shifts from current state science standards (National Research Council, 1996, 2000) to the CCSS and NGSS, these types of strategies will continue to be important—but not sufficient. The CCSS and NGSS "frame content learning as engagement in disciplinary practices, implying an active learning process in which language plays a key role" (Valdés, Kibler, & Walqui, 2014, p. 10)—for example, "engage in argument from evidence" is one of the NGSS practices, "comprehend as well as critique" is included in the CCSS for English Language Arts, and "construct viable arguments and critique the reasoning of others" is in the CCSS for mathematics (Stage, Asturias, Cheuk, Daro, & Hampton, 2013, p. 276). Given the richness of these disciplinary practices, it is expected that the CCSS and NGSS will lead to "classrooms that are also rich language learning environments for ELLs" (Lee et al., 2013, p. 231). In order to help all students, and ELLs in particular, engage in these practices, science teachers will need new ways to teach science and language concurrently. Specifically, teachers will need to use strategies to promote students' productive use of the language for "doing" science while engaging in these language-intensive practices (Lee et al., 2013; Valdés et al., 2014).

As standards change and our conceptions of quality teaching practices evolve, however, and along with them our objectives for teacher professional development, we must also acknowledge and capitalize on any effective strategies in our teachers' current instructional repertoires that may already be consonant with the new standards. For example, Santos et al. (2012) outlined several critical areas for future teacher professional development to support ELLs in the context of the CCSS (and NGSS) that go beyond the use of simple strategies. One such area is the incorporation of what the authors call language supports, or ways in which "classrooms and schools can be organized to support students in continually building a deep understanding of language and content" (p. 107). Incidentally, one of the language supports proposed by Santos et al. (2012)—grouping students at different levels of English proficiency who share the same home language—is a strategy that, in the present study, was reported to already be in frequent use by elementary science teachers.

A significant limitation bears mentioning: Data on teachers' actual use of language development and home language strategies in the classroom were not available. Because the study used teacher self-reported data, it is possible that teachers over-reported using strategies that they perceived to represent best practices. It is also possible that they under-reported using strategies, as was noted in Lee et al. (2008).

Conclusion

This study contributes important baseline information regarding the current state of elementary science teachers' reported language-related strategy use. We found that science teachers reported frequent use of several language-related strategies aimed at facilitating access to and comprehension of science content for ELLs in their classrooms. Even more encouraging, it appears from the data that teachers may be particularly sensitive to the needs of ELLs and former ELLs, as teachers with these students in their classrooms reported more frequent use of the strategies. We maintain that these language development and home language strategies with which teachers are already familiar may serve as a meaningful bridge to the more integrated approach to science and language learning that is promoted in the CCSS and NGSS. Professional development aimed at preparing elementary science

teachers for these standards would do well to build on teachers' existing practices to ensure rigorous, equitable science instruction for ELLs.

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Footnotes

[1]The state in which the study took place was using its own set of standards, not the Next Generation Science Standards (NGSS). As of the writing of this paper, 12 states have adopted the NGSS, and curricula based on the NGSS are only beginning to be developed.

[2]Exploratory factor analyses confirmed that the items in the questionnaire formed two independent scales: language development strategies and home language strategies.

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Appendix

Teacher Questionnaire Items and Scales

Language Development Strategies (Cronbach's α: .66)

In your most recent teaching position, please indicate how often YOU did the following in your science lessons.

	Never or almost never	Some lessons	Most lessons	Every lesson
a. Present information in multiple graphic formats (e.g., graphs, charts, photos, diagrams, models, etc.)	1	2	3	4
b. Use realia (including hands-on activities) to help students develop academic language of science	1	2	3	4
c. Make science text comprehensible (e.g., underline important information, identify main ideas and details, make inferences, etc.)	1	2	3	4
d. Make science talk understandable (e.g., clearer enunciation, longer wait time)	1	2	3	4
e. Use science terms in various contexts (e.g., introduction, science investigation, writing, discussion, etc.)	1	2	3	4

Home Language Strategies (Cronbach's α: .81)

In your most recent teaching position, please indicate how often YOU did the following in your science lessons.

	Never or almost never	Some lessons	Most lessons	Every lesson
a. Encourage more English proficient students to assist less English proficient students in their home language	1	2	3	4
b. Allow students to discuss science using their home language	1	2	3	4
c. Introduce key science vocabulary terms in both their home language and English	1	2	3	4
d. Allow students to write about science ideas or experiments in their home language	1	2	3	4