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Urban Third Grade Teachers' Practices and Perceptions in Science Instruction with English  
Language Learners

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## Abstract

The study examined relationships among key domains of science instruction with English language learning (ELL) students based on teachers' perceptions of their classroom practices (i.e., what they think they do) and actual classroom practices (i.e., what they are observed doing). The four domains under investigation included: (1) teachers' knowledge of science content, (2) teaching practices to support scientific understanding, (3) teaching practices to support scientific inquiry, and (4) teaching practices to support English language development during science instruction. The study involved 38 third grade teachers participating in the first-year implementation of a professional development intervention aimed at improving science and literacy achievement of ELL students in urban elementary schools. Based on teachers' self-reports, practices for understanding were related to practices for inquiry and practices for English language development. Based on classroom observations in the fall and spring, practices for understanding were related to practices for inquiry, practices for English language development, and teacher knowledge of science content. However, we found a weak to non-existent relationship between teachers' self-reports and observations of their practices.

Urban Third Grade Teachers' Practices and Perceptions in Science Instruction with English  
Language Learners [\(Editor Comment 10\)](#)

As the school-age population in the U.S. becomes increasingly diverse, many teachers are not prepared to meet the learning needs of students from varied backgrounds. Teachers generally do not know how to work with students from diverse cultures or who speak a language other than English (Bryan & Atwater, 2002; National Center for Education Statistics, 1999). This problem is intensified for elementary school teachers who lack knowledge of science content and content-specific teaching strategies to promote students' scientific understanding and inquiry (Garet, Porter, Desimone, Birman, & Yoon, 2001; Kennedy, 1998). The problem is especially notable, as science has become part of high-stakes testing and accountability in the U.S.

The research literature on teachers' practices in teaching science to English language learning (ELL) students is limited. While ELL students must learn science and English proficiency simultaneously, the research traditions and teacher education programs have kept these two issues largely separate (Lee, 2005). There is little research on (1) how key domains of science instruction with ELL students relate to one another and (2) how teachers' perceptions of their own teaching practices relate to their observed teaching practices in these domains. Without such knowledge, there is little hope for designing effective interventions to better serve ELL students and their teachers in the science classroom.

This study examined relationships among key domains of science instruction with ELL students based on third-grade teachers' survey-based self-reports of their classroom practices (i.e., what teachers say they do) and third-party observations of those practices (i.e., what teachers are observed doing in the classroom). The four domains included: (1) teachers' knowledge of science content, (2) teaching practices to support scientific understanding, (3)

teaching practices to support scientific inquiry, and (4) teaching practices in science to support English language development. Specifically, the study examined the following research questions: (1) how were the four domains related to one another as measured by teachers' self-reports and classroom observations, respectively? and (2) how were teachers' perceptions (measured by self-reports) and teachers' practices (measured by classroom observations) related to one another?

The results of the study should inform and help refine reform-oriented professional development. If the above four domains of teachers' knowledge and practices are related, then professional development can be based on strategic efforts that seek to incorporate the related domains concurrently. When these domains are treated in isolation from one another, teachers' professional growth may be impeded, leading to diminished quality of science instruction provided to all students including ELL students.

#### Related Research

Teachers need to know the subject matter that they are required to teach and have content-specific teaching strategies (Kennedy, 1998). Teachers should help their students develop deep and complex understandings of science concepts, make connections among science concepts, and apply science concepts in explaining natural phenomena or real world situations (National Research Council [NRC], 1996; 2007). Teachers should also recognize the role of prior knowledge, particularly students' misconceptions, in shaping students' understanding. Additionally, teachers should enable students to engage in scientific inquiry by recognizing problematic and incomplete information, making reasoned and well-supported arguments, and justifying solutions based on the evidence (NRC, 2000).

Classroom environments should be created by teachers of ELL students to promote development of both general and content-specific language (Wong-Fillmore & Snow, 2002). It is also important for teachers to take a developmental perspective on language and to create appropriate expectations about language development. In addition, teachers utilize this knowledge when teaching in academic content areas, such as science. As a result, teachers support students at all levels of English proficiency to learn academic language, give students at various levels opportunities to be engaged, and afford opportunities for students to display their learning in different modalities.

#### *Relationships among Domains of Science Instruction with ELL Students*

Many teachers assume that ELL students must acquire English before learning science and are unaware of linguistic influences on science learning (Bryan & Atwater, 2002). However, an emerging literature highlights the integration of science with English proficiency for ELL students (Fathman & Crowther, 2006; Lee, 2005). For example, the acquisition of “science talk” includes more than just grammatical structures and lexicons (Lemke, 1990). Science talk includes knowledge of various sub-registers representing specific disciplines. It also employs non-technical terms that have meanings unique to scientific contexts (e.g., matter, force, energy, space) but differ from their every day use. Additionally, science talk requires ways of communicating specific to science disciplines, as students engage in science inquiry by formulating hypotheses, designing investigations, collecting and interpreting data, drawing conclusions, and communicating results (NRC, 2000).

ELL students can benefit greatly from hands-on and inquiry-based science instruction (Lee & Fradd, 1998; Rosebery, Warren, & Conant, 1992). Hands-on activities are less dependent on formal mastery of the language of instruction and, thus, reduce the linguistic burden on ELL

students. Hands-on activities provide structured opportunities for developing English proficiency in the context of authentic communication about science. Hands-on activities based on natural phenomena are more accessible to students with limited science experience than is decontextualized textbook knowledge. Finally, hands-on activities promote students' communication of their understanding in a variety of formats, including gestural, oral, graphic, and textual.

### *Relationships between Perceptions and Practices*

There has been long-time interest in the relationship between teachers' self-reported practices (commonly referred to as "perceptions") and observed practices (commonly thought of as "real" practices). Studies indicate various relationships among different domains of classroom teaching. Fennema and Franke (1992) found that mathematics teachers' level of content knowledge was related to differences in teaching practices, such as the richness of the materials being taught and the depth of the classroom discussion. In studies of science and mathematics teaching, Morrell, Wainwright, and Flick (2004) explored the links between pre-service teachers' perceptions of their practices as determined from interviews and their classroom practices as determined from observations. Although pre-service teachers tended to be fairly accurate in describing what they did in the classroom, they sometimes overstated their instructional skills.

The literature also addresses the impact of professional development interventions on changes in teachers' perceptions and practices. Hart and Lee (2003) provided professional development to elementary school teachers serving diverse student groups. Both quantitative and qualitative results indicated positive changes in teachers' perceptions and practices simultaneously. As teachers expressed a broader and more integrated conceptualization of literacy in science instruction, they integrated reading and writing in science instruction more

systemically and extensively, and provided more effective linguistic scaffolding to enhance students' scientific understanding.

## Method

### *Research Setting*

This study was conducted in a large school district located in the Southeastern U.S. The district is composed of a linguistically and culturally diverse student population. During the 2004-2005 school year, the student population in the school district was 60% Hispanic, 28% Black (including Haitian and Caribbean Islanders), 10% White Non-Hispanic, and 2% Asian and Native American. Across the district, 72% of elementary students participated in free or reduced price lunch programs, and 24% were categorized as limited English proficient (LEP) according to the state definition.

In May 2004, schools were invited to participate in a five-year research and development project based on three criteria: (a) percentage of ELL students (predominantly Spanish or Haitian Creole-speaking students) above the district mean at the elementary school level, (b) percentage of students on free or reduced price lunch programs above the district mean at the elementary school level, and (c) school grades of primarily C or D according to the state's accountability plan. Public schools in the state are assigned a letter grade (A, B, C, D, or F) based on a formula from the state's school accountability plan. At the time of this study, the school grade was based on student performance in reading and mathematics from grades 3 through 5 and writing at grade 4. These three criteria served as the boundary for selection of the schools to our larger project. Of the 206 elementary schools in the district, 33 schools met these criteria and 15 schools expressed a desire to participate in the research. Seven schools were assigned to the treatment group and eight schools to the comparison group.

### *Teacher Participants*

For our school-wide initiative, we invited every third grade teacher in each treatment school to participate in our professional development intervention, described below. Of the 44 teachers who participated in the intervention, 38 teachers completed the entire school year and were included in this study. In terms of demographic backgrounds, 34 teachers were female and 4 male. Of these teachers, 19 identified themselves as Black, 9 as Hispanic, 5 as White Non-Hispanic, 2 as Haitian, 2 as Asian, and 1 “other.” In addition, 32 teachers reported that English was their native language, 5 Spanish, and 1 Haitian Creole. In terms of professional backgrounds, 1 teacher reported having a specialist degree (beyond master’s degree), 15 had master’s degrees, and 22 had bachelor’s degrees. For training in the area of English for Speakers of Other Languages (ESOL), 3 teachers reported having bachelor’s or master’s degrees in ESOL, 13 had endorsements through college coursework, 21 had endorsements through district training, 3 had endorsements that had been grandfathered in through long-time teaching experience, and 5 had no preparation.

### *Professional Development Intervention*

*Curriculum units.* Teachers used a grade 3 curriculum that was closely aligned with the state science content standards and also followed recommendations by the *National Science Education Standards* (NRC, 1996). The three units for grade 3 included Measurement, States of Matter, and Water Cycle and Weather. The teachers’ guide for each unit begins with an explanation of (a) how to promote students’ science inquiry and understanding of key science concepts and “big ideas” (patterns of change, systems, models, and relationships) to explain natural phenomena and (b) how to incorporate English language and literacy development as part of science instruction.

First, the student books support standards-based science learning that is focused on promoting students' science inquiry that is initially teacher-directed but gradually moves toward student-initiated. While the books emphasize key science concepts and big ideas, the complexity of science concepts increase as students move through the units. Teachers' guides provide content-specific teaching strategies for each lesson, including suggestions on how teachers may provide different levels of guidance and scaffolding. Teachers' guides also give suggestions for organizing and executing hands-on activities, as well as cautions about possible problematic outcomes and how to respond to these. Additionally, teachers' guides provide science background information and explanations for the questions posed in the student books, with a particular emphasis on students' common misconceptions and learning difficulties.

Second, both student books and teachers' guides highlight activities and strategies to foster reading and writing during science instruction. For example, the units incorporate comprehension questions about inquiry activities, various language functions (e.g., describing, explaining, reporting, drawing conclusions) to promote science inquiry, and narrative vignettes and expository texts related to everyday experiences. The units also address the needs of ELL students by providing explicit guidance to promote their English proficiency. For example, language load at varying levels of English proficiency becomes increasingly more demanding as students progress from grade 3 through 5. Key science terms in English, Spanish, and Haitian Creole are provided to support communication and comprehension. Multiple modes of communication and representation (gestural, oral, graphic, textual) are encouraged.

*Teacher workshops.* During the first year of the project, third grade teachers in the treatment group attended five full-day workshops during regular school days that covered the content of each of the units and also included data collection activities. First, the workshops

focused on familiarizing teachers with the science content, hands-on activities, common student misconceptions, and potential learning difficulties in each lesson. Another area of science emphasis involved inquiry. Project personnel and teachers discussed the nature of science inquiry (NRC, 2000) and the teacher-explicit to student-initiated continuum to promote more student-centered and open-ended inquiry (Lee, 2002). Still another area of emphasis involved scientific reasoning of students and teachers' reflections on student reasoning.

Second, the workshops focused on incorporating English language and literacy development into specific science lessons. Project personnel described various strategies for developing students' reading and writing skills using examples in the Measurement unit. Project personnel also described how to provide linguistic scaffolding for ELL students. Additionally, teachers worked in small groups to incorporate ESOL strategies in selected lessons from the Water Cycle and Weather unit.

#### *Instruments and Data Collection*

The study employed a teacher questionnaire and classroom observation guideline. Although the teacher questionnaire was administered to the teachers in both the treatment and comparison schools, classroom observations were conducted only with the teachers in the treatment. As a result, this study reported the data from the treatment group.

*Questionnaire.* Based on relevant literature, our previous research (Hart & Lee, 2003; Lee, Hart, Cuevas, & Enders, 2004; Newmann, Secada, & Wehlage, 1995), and extensive pilot-testing in the fall of 2004, we developed a questionnaire to measure teachers' self-reported knowledge and practices in teaching science to ELL students. The questionnaire consisted of items that were grouped together to form scales that measure the four domains of teachers' perceptions of their knowledge and practices. Each scale used a 4-point rating system. Based on

the teachers' responses in this study, internal consistency reliability estimates for the scales using Cronbach's alpha ( $\alpha$ ) ranged from .72 to .90, which were within an acceptable range.

The questionnaire included the following scales. First, the *teacher knowledge of science content scale* measures teachers' reported knowledge in teaching science topics at their grade level (Cronbach's alpha = .90). Second, *the practices for scientific understanding scale* measures teachers' reported practices in teaching science for understanding (Cronbach's alpha = .72). Third, *the practices for scientific inquiry scale* measures teachers' reported practices in teaching science for inquiry (Cronbach's alpha = .76). Finally, the *practices for English language development scale* measures teachers' reported practices in using ESOL strategies or ESOL students' home languages to support English language and literacy in science instruction (Cronbach's alpha = .88).

To help teachers think about their classroom practices and guard against their responding quickly without thinking about these practices, the questionnaire items were framed in terms of specific time periods (such as "in the last month") and were focused on practices that teachers engaged in for sustained periods of time (such as "for at least 10 minutes"). The teachers completed the questionnaire for 30-45 minutes during the final teacher workshop in May of 2005.

*Classroom observations.* All third grade teachers were observed using scales adapted from our previous research on science instruction (Lee et al., 2004; Newmann et al., 1995) and English language and literacy development in science instruction (Hart & Lee, 2003). Each observation scale used a 5-point rating system. In addition to quantitative ratings of teaching practices during specific lessons, observers produced extensive narrative field notes and justifications for their ratings.

The classroom observation guideline included the following four scales. First, the *teacher knowledge of science content scale* measures the extent to which the teacher's mastery of the science content of the lesson is accurate and comprehensive. Second, the *scientific understanding scale* measures the extent to which students demonstrate a deep understanding of science. Third, the *scientific inquiry scale* measures the extent to which students engage in scientific inquiry. Finally, the *teacher support of English language development scale* measures the extent to which teachers support students' comprehension of academic content and development of English language. The *teacher knowledge of science content* and the *teacher support of English language development* scales focus on teacher practices, whereas the *scientific understanding* and *scientific inquiry* scales measure the instructional environment that the teacher and students jointly create.

Prior to the classroom observations in the fall of 2004, two project members participated in reliability training using the observation scales to rate videotaped lessons from our previous research. These project members continued training by observing lessons in real time and rating them on the scales until they established inter-rater agreement of over 90%. Prior to conducting the second round of observations in the spring of 2005, the two members repeated the same training procedures using additional videotaped lessons from our previous research. Each third grade teacher was observed once in fall 2004 and once in spring 2005. The fall 2004 observations were conducted while teachers taught the Measurement unit, and the spring 2005 observations were conducted when most teachers taught the Water Cycle and Weather unit. Each observation typically lasted from 45 minutes to an hour.

#### *Data Analysis*

Of the 44 teachers who participated in our professional development intervention, the analysis for this study included only those 38 teachers who completed the entire school year.

Thus, the analysis was based on 38 questionnaire responses in the spring of 2005 and 76 classroom observations in the fall of 2004 and the spring of 2005.

*Relationships among domains of teachers' perceptions.* To measure the extent to which teachers reported their own knowledge of science content at their grade level, the questionnaire items used a 4-point rating system (1 = not knowledgeable; 2 = somewhat knowledgeable; 3 = knowledgeable; 4 = very knowledgeable). Similarly, to measure the extent to which teachers reported practices for scientific understanding, scientific inquiry, and English language development in their own teaching, the items used a 4-point rating system (1 = never or almost never; 2 = some lessons; 3 = most lessons; 4 = every lesson).

The questionnaire items were grouped together to form scales. The score for each scale was computed using the average of the responses to the items that comprised the scale. 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. A scale score was computed only for those respondents who had valid responses for at least 75% of the items in the scale. If someone answered fewer than 75% of a scale's items, the respondent's scale score was set to be missing and omitted from that particular scale. Missing data for each scale are shown in Tables 1 and 4 below.

*Relationships among domains of teachers' practices.* The two observers followed standard conventions for the format of the field notes. Field notes were color-coded for episodes that illustrated reform-oriented practices for each of the four scales under investigation. For each scale in each lesson, a rating was given ranging from 1 (lowest) to 5 (highest) based on two criteria: (a) the frequency or intensity of reform-oriented practices and (b) the percentage of students who were engaged in such practices. In addition to the ratings, justifications were

provided based on the evidence in the field notes of the lesson. The two observers and a third project member reviewed the entire set of observation notes to ensure reliability.

*Relationships between teachers' perceptions and practices.* The relationships among the four domains of teachers' perceptions, among the four domains of teachers' practices, and between teachers' perceptions and practices were examined using Pearson  $r$  correlations. For each set of analyses, both the coefficients and significance levels are reported. Scatterplots were scrutinized for possible linear trends among statistically significant correlated variables.

## Results

### *Relationships among Domains of Science Instruction with ELL Students*

*Relationships among domains of teachers' perceptions.* The results of the intercorrelations among the questionnaire scale scores are displayed in Table 1. Though 38 teachers participated, there were missing data for some of the variables causing the sample size to decrease. There were two statistically significant correlations. The practices for understanding scale is statistically significantly correlated with both the practices for inquiry ( $r = .59$ ) and practices for English language development ( $r = .49$ ) scales. Both correlations were positive and moderate in size.

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 Insert Table 1 about here  
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*Relationships among domains of teachers' practices.* Table 2 below shows the correlations among the fall observation variables. The results show three statistically significant correlations. The practices for understanding scale is related to science knowledge ( $r = .33$ ); this is a positive, low correlation. Practices for understanding is also related to practices for inquiry ( $r$

= .46) and practices for English language development ( $r = .49$ ); both are positive, moderate correlations.

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 Insert Table 2 about here  
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Table 3 below shows the correlations among the spring observation variables. Three statistically significant correlations are present, and these are the same correlations as those that were statistically significant in the fall data. The practices for understanding scale is related to science knowledge ( $r = .48$ ), practices for inquiry ( $r = .52$ ), and practices for English language development ( $r = .41$ ); all of these are positive, moderate correlations.

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 Insert Table 3 about here  
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*Relationships between Teachers’ Perceptions and Practices*

The results of the correlations between the teacher questionnaire scales and the comparable scales from the fall and spring observations are displayed in Table 4. There is one statistically significant correlation between the teachers’ reported practices for inquiry on the questionnaire and the actual practices for inquiry observed in the fall ( $r = .39$ ); this is a positive, fairly moderate correlation.

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 Insert Table 4 about here  
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Discussion and Implications

Our most important finding is the key relationship between practices for understanding (PU) and the other domains (Research Question 1). Based on teachers’ self-reports, the practices for understanding were related to practices for inquiry (PI) and practices for English language

development (PELD). Additionally, based on classroom observations in the fall and spring, practices for understanding were related to practices for inquiry (PI), practices for English language development (PELD), and teacher knowledge of science content (SK). The results indicate that practices for understanding are related to the other practices *across* both sets of instruments and across times—an important replication.

Our second finding is a weak to non-existent relationship between teachers' self reports and our observations of their practices (Research Question 2). This finding could be attributed to several factors. One possible explanation is the difficulty of observing in a particular lesson what teachers reported to have taken place during a month's time (recall that many survey items asked how many times teachers engaged in an activity during the previous month for a minimum of ten minutes). Future research could be conducted using more frequent or longer observations to increase reliability of classroom observation ratings. Another possible explanation is that teachers might perceive their own knowledge of science content and classroom practices differently than the goals of content knowledge and reform-oriented practices as measured by classroom observation ratings. Still another possible explanation is that our observers might have been using more stringent criteria than those the teachers used to rate themselves. Finally, it may be that the two instruments—self-report surveys and observation ratings—were tapping into different aspects of their respective constructs.

The results of the study contribute to the knowledge base on professional development for elementary school teachers of ELL students. While the study is correlational and thus cannot be used to draw causal inferences, our results offer initial insights into how connections may be present among key domains of teachers' knowledge and practices in science with ELL students. Our findings are consistent with Romberg, Carpenter, and Dremock's (2005) claim that

*understanding matters*. In our study, understanding matters as a practice that is central to other reformed-oriented practices in the teaching of science with ELL students.

Results from analysis of the first year of this intervention provide guidance for our ongoing professional development and for others working with teachers in similar efforts. Professional development may focus on teaching practices that support student understanding of science. Professional development should then relate practices for science understanding to practices for science inquiry and practices for English language development of ELL students, as well as teachers' knowledge of science content. Our results suggest that these sets of teachers' knowledge and practices co-emerge, as related to understanding. We will further investigate these relationships and their practical implications within our larger project across grade levels and across years.

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Table 1

*Intercorrelations Among Domains of Teachers' Perceptions Using Questionnaire*

	SK ( <i>n</i> )	PU ( <i>n</i> )	PI ( <i>n</i> )
Teacher science knowledge (SK)	--	--	--
Practices for understanding (PU)	-.12 (38)	--	--
Practices for inquiry (PI)	.14 (37)	.59** (37)	--
Practices for English language development (PELD)	-.14 (32)	.49** (32)	.29 (31)

\*  $p < .05$       \*\*  $p < .01$

Values in parentheses represent the number of teachers for each correlation.

Table 2

*Intercorrelations Among Domains of Teachers' Practices Using Fall Observations (n = 38)*

	SK	PU	PI
Fall Teacher science knowledge (SK)	--	--	--
Fall Practices for understanding (PU)	.33*	--	--
Fall Practices for inquiry (PI)	-.04	.46**	--
Fall Practices for English language development (PELD)	.29	.49**	-.05

\*  $p < .05$       \*\*  $p < .01$

Table 3

*Intercorrelations Among Domains of Teachers' Practices Using Spring Observations (n = 38)*

	SK	PU	PI
Spring Teacher science knowledge (SK)	--	--	--
Spring Practices for understanding (PU)	.48**	--	--
Spring Practices for inquiry (PI)	.22	.52**	--
Spring Practices for English language development (PELD)	.21	.41**	-.07

\*  $p < .05$       \*\*  $p < .01$

Table 4

*Intercorrelations Between Teachers' Perceptions and Practices Using Both Questionnaire and Observations*

Questionnaire	Fall Observations ( <i>n</i> )	Spring Observations ( <i>n</i> )
Teacher science knowledge (SK)	-.001 (38)	-.17 (38)
Practices for understanding (PU)	.09 (38)	.09 (38)
Practices for inquiry (PI)	.39* (37)	.24 (37)
Practices for English language development (PELD)	-.17 (32)	-.03 (32)

\*  $p < .05$       \*\*  $p < .01$

Values in parentheses represent the number of teachers for each correlation.