Locating the Learning Trajectories of Heterogeneous Elementary School Students in Their Participation of Science Inquiry and Literacy Activities

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The following preliminary data was collected in the second year of a longitudinal four year study funded by the National Science Foundation of the Science Instruction For All (SIFA) project addressing how science inquiry learning occurs in 3 to 5th grade multilingual Northern California classrooms. SIFA is an augmentation and replication of a simultaneous study of the Science For All project based southern Florida (Fradd and Lee 1995; Lee and Fradd 1998). This paper, however, examines the unfolding of the SIFA science inquiry activities in various classroom and schools in a large urban Northern California school district over the 2001/2002 academic year. This work builds from recent research interested in formulating effective instructional approaches for promoting science inquiry among culturally and linguistically heterogeneous elementary school populations for which little is known (García 2002). Research on how access across the curriculum for all students is achieved necessarily means understanding how teaching and learning practices incorporate students' cultural and linguistic resources.

While the corpus of project data includes structured teacher interviews, teacher questionnaires, student unit tests, and student writing assessments, this paper focuses mainly on describing everyday student and teacher interactions and practices. The paper, therefore, pulls primarily from preliminary findings from classroom observations. The following table lists the major research questions and data sources that the project will use to examine classroom interactions.

Research Questions	Data Sources
1. What are the developmental trajectories for conducting science inquiry of English primary language and linguistically diverse elementary students? a. How do students learn to conduct science inquiry with less teacher guidance and/or peer scaffolding? b. How do students learn to conduct more complex inquiry including (a) experimentation involving more than one variable and (b) evidence in support of theories?	Student Data • Unit Tests • NAEP/TIMSS Tests • Writing Samples • Classroom Observations
2. What is the process of instructional intervention as teachers provide effective scaffolding by considering: a. the nature of science and literacy with students' language and cultural experiences, and b. the teacher explicit to student exploratory continuum?	Teacher Data • Classroom Observations • Teacher Surveys • Teacher Interviews

An initial pilot project was conducting where a group of six 3rd and 4th grade teachers implemented science measurement lessons during a condensed four week summer school session prior to entering schools in the Fall of 2001. Two teachers implemented the Spanish language versions of these lessons while rest were implemented in English. Teacher suggestions from the summer pilot were used to make adjustments to curriculum and assessment materials. After the piloting, four of the summer pilot teachers continued to participate the project.

During the 2001/2002 academic year, a total of nine3rd and 4th grade teachers volunteered to teach SIFA measurement and matter units. Teachers were given the option of choosing the language of instruction for science lessons. Except for one teacher who implemented the matter unit in Spanish, virtually all lessons were done in English only settings. In general, bilingual teachers (including teachers

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who taught in bilingual settings) opted for English language instruction during science instruction time. Instruction took place, on average, three hours a week. Some teachers taught science as part of language arts or mathematics instruction. Other classrooms used science time for integrating students normally grouped separately into bilingual and mainstream classrooms. All teachers were provided with complete sets of materials, including teachers' guides, copies of student books, and science supplies. Moreover, two teacher training sessions were held to review science units and project activities.

The research pursuit of understanding developmental trajectories of heterogeneous elementary school students can be located through longitudinal observations of everyday student interactions participating in emerging classroom scientific practices, routines and activities(Moll 2000). Gutiérrez (2002)succinctly presents the study of classroom practices as the endeavor of "developing a language to describe what happens in learning environments, to unpack how routine activity is constituted, and to identify the central tensions in learning activity in order to understand how students becomes competent members of communities…how they learn in these contexts" (p.314). A major theme explored in this study revolves around understanding how student participation in science and literacy classroom activities, in racially/culturally and linguistically diverse contexts, intersect with students' previous lived experiences and practices. Learning appropriate rules, procedures, and competences associated with distinct cultural practices, like scientific practices, are defining aspects of participation and membership in any community (Rogoff 1990). In his study of how interactions are organized in classrooms, Mehan (1979) similarly defines interactional competence in terms of effective participation or membership in classroom activities. To be judged as effective or successful members of classroom communities, students must display and interpret several interactional norms beyond a mere mastery of academic subjects as described in the following passage.

> They must know with whom, when, and where they can speak and act, and they must provide speech and behavior that are appropriate for a given classroom situation. Students must also be able to relate behavior, both academic and social, to varying classroom situations by interpreting classroom rules. (Mehan 1979:133)

Successful participation in classroom activities is a fundamental part of interactional competence for all students. Recent reforms propose increased attention on teaching bilingual and second language learners a restricted academic register (e.g. academic language) as a strategy to overcome the challenge of testing academic English competency across the public school curriculum and the uneven familiarity by some students of the academic discourse used in schools (Fillmore and Snow 2000).

All students continually bring valuable linguistic and cultural resources reproduced, indexed, and transformed through participation in a variety of cultural practices in and out of school contexts. Early findings from ongoing research on science learning with elementary school students from culturally, linguistically, and socio economically diverse backgrounds highlight three important pedagogical principles including: 1) the merging cultural and linguistic funds of knowledge that students bring into the classroom with traditional scientific concepts, 2) the examination of students' everyday knowledge and language in conjunction with scientific practices, and 3) the development and use scientific concepts and tools can occur once students are engaged *in* scientific inquiry and activities (Lee 1999).

1. Classroom observations

Classroom field notes were taken following participant observation methodology where the researchers played the dual role of key colleague and participant observer in the implementation of science lessons. Researchers often collaborated and assisted teachers and students while conducting science inquiry or examining scientific tasks. Participant observation allowed us to identify moment to moment and enduring cultural patterns through an analysis of learning through shifting interactions and changes of participation (Rogoff 1990). The length of weekly classroom observations varied but averaged about 1 hour. The SIFA research team spent over 420 hours in the classroom over the course of this academic year.

Quantitative and qualitative instruments are used to document how classrooms mediate the learning of science inquiry. Because the analysis of the data is still in progress, these results can only be described as preliminary findings that may guide future analysis. While conducting these classroom observations, we were interested in several theoretical and more procedural questions including:

a. How are teachers developing or modifying science lessons and why?

b. How are students grouped and lessons structured?
c. How are broader pedagogical goals of science inquiry and language development emphasized in the classroom?
d. How are teachers mediating literacy and science issues particularly in relation to students' linguistic and cultural experiences or funds of knowledge?

The following is a synthesis of the qualitative findings that cut across the project's research questions.

1.1 Varied classroom arrangements

We found that teachers employed a variety of classroom arrangements for the science units. For example, teachers varied the use of classroom space and student groupings by designing activities that required whole class, small group, and individualized work both inside and outside the classroom. In some cases, students explored the school environment to complete lessons. Overall, children appeared enthusiastic when working on the different science activities. However, a real concern expressed by teachers and observed by the research team was the tension between promoting student driven science inquiry among all students and managing student conduct whenever necessary.

Depicted in the science lesson routines of a few teachers was a great deal of attention placed on following a systematic way of managing and assigning student tasks, roles and responsibilities for class and science materials. A major focus of some classes was therefore teaching students self responsibility for the coordination of lessons. This focus is interesting given the two central, albeit, competing tension imbedded in science inquiry according to some teachers: (a) the demand of exact detailed execution of specific tasks and (b) the emphasis on self driven/student driven meaning making activities.

1.2 Science tools and materials

Some teachers constructed ample opportunities for students to actively participate in each experiment. The extent to which either scientific authority or manipulation of science materials centered on students or teachers varied by classroom and by science lesson objectives. However, teachers made concerted efforts that even in cases where conditions were not ideal, students had some opportunity to try out new science concepts and tools. For example, even when teachers were leading or introducing experiments, they would pass around artifacts (e.g. bag with ice) so the children could make estimates and write down their hypotheses before getting started in small groups. An early challenge for students was the reading of data graphic organizers that required the recording of estimation and actual measurements in different measurement systems. All teachers spend a great deal of time explaining how to use rulers, weight scales, graduated cylinders, and thermometers even beyond the period when measurement was the focus of activity.

1.3 Teaching science through dialogue and talk

Given newness of teaching science for most teachers and that many teachers felt that lessons required careful introductions of the inquiry process and vocabulary, they used conversation and dialogue as a primary strategy to reinforce major science concepts and procedures as opposed to text centered activities like reading or writing. Some form of writing was used in all lessons but dialogue or talk appeared to be prevailing strategy. Some teachers took great effort to keep children focused through talk and in general, encouraged discussion of activities and process. It was not uncommon to observe teachers adjusting their language to enhance students' understanding of scientific discourse. Most teachers communicated at or slightly above their students' level of understanding but certainly not all.

The preponderance and direction of dialogue ranges between teacher to student and student to student dialogue arrangements. There were many cases where the teacher asked most questions and the interactions were primarily directed from teacher to students (e.g. IRE) (Mehan 1979). When this happened only a few students actively interacted with the teacher or self selected for participation in the science discussion. In these cases students were more engaged in answering rudimentary fill in the blank type of questions (i.e., "Is the water going up or going down?), and the teacher became the principal source of knowledge. In these instances it appeared that getting the correct answer was the focus of activity, rather than exploring possible explanations or descriptions of phenomena observed. Nevertheless, teachers across all classrooms attempted, at least momentarily, to raise questions that required inference or interpretative type of responses, such as applying ideas, making predictions, and forming generalizations.

1.4 Science and literacy

We found disparate approaches by teachers in their development of science inquiry and literacy. In two mostly English only classrooms, for example, teachers explicitly stated that their main goal with literacy development is to prepare the students for writing in the fourth grade. Writing was an important part of their teaching as a way to prepare students for meeting grade level standards. The students kept a journal in the classroom and were encouraged to write regularly. In these two classes, there was a deliberate attempt to connect writing development and scientific inquiry to larger learning standards like writing conventions, style, voice, and organization.

A few teachers working in linguistically heterogeneous classrooms focused on writing through the use of the science student workbooks. For these teachers, writing was done collaboratively in groups of four and centered on problem solving using the scientific method. Through this approach, all the students in each group had to work together and write down each element of the framework instead of reading through the framework in the student workbook individually.

At quite the other end of the spectrum, we found many teachers who paid minimal attention to monitoring expository writing development during science inquiry class. They generally followed the directions and requirements of the workbook literally and did not extend activities further. Although the student workbooks frequently demanded expository reading and writing tasks, the workbooks generally required only one to two sentence responses or choosing a preferred response from a set of multiple selections. Writing expository essays where students are required to define concepts, compare and contrast, classify, show cause and effect, and draw conclusions was rarely observed. Other aspects of expository writing like making graphs, data tables, and charts generally received more reinforcement by teachers.

1.5 Diverse student composition of classroom

For the most part and given certain cases where the science class was used particularly to mix students, classrooms were composed of students with ethnically/racially and linguistically diverse backgrounds including classrooms with African American, Chinese speaking, Korean speaking, Spanish speaking, Asian and Latino descent (English dominant) students.

We found teachers rarely using non English language as a broader and purposeful scaffolding strategy, such as Spanish equivalents of scientific concepts like evaporation or condensation. Teachers did use Spanish or Cantonese, individually ad hoc with students that required greater elaboration and appeared lost. This, of course, excludes the case of one Spanish bilingual classroom, where Spanish was used as the primary language of instruction. Despite the lack of inclusion of non English language by teachers as part of linguistic and literacy scaffolding, we observed students using Spanish, Korean or Chinese while working in pairs/groups and occasionally code switching between English and Spanish or Cantonese. It was interesting to find that some students used Cantonese frequently when they were involved in discussions with their group partners and while performing hands on activities.

1.6 Monitoring of student understanding and previous knowledge

A finding that links many of project's core questions and themes is related to the range of contrasting ways that teachers monitored student comprehension of science concepts by connecting or not connecting with students' previous cultural experiences. A common routine was for teachers to heavily monitor and mediate student understanding and comprehension of lessons after an initial introduction of the lesson and during the group work phase of the lesson.

In a few cases, teachers presented new topics or lessons by relating it to students' prior knowledge. These teachers would try to integrate examples from students' daily experience when explaining new concepts. For example, when explaining the characteristics of the three states of matter, the teacher pointed to familiar objects in the classroom and objects students brought from home (e.g., backpack, juice bottle) to compare and contrast with those objects listed in the science workbooks (e.g., water, chocolate bar).

However, overall we seldom observed instances where students' linguistic and cultural experiences outside of school were elicited as a way to either expand notions of literacy/scientific knowledge or to augment students' understanding of classroom topics.

2. Classroom observation protocol

The following section is a synthesis of the qualitative findings (e.g. classroom observation protocol) that support many of the previous qualitative findings project's research questions. The classroom observation scores represent 17 individual domains (1 17) and four domain areas including science and math (SM), cultural responsiveness (C), linguistic scaffolding (LGS), and literacy scaffolding (LTS). The classroom observation protocol (COP) is an instrument designed to examine and understand how classrooms are organized to promote science and literacy with linguistically and culturally diverse elementary school students. In particular, these observations focus on how teachers integrate the nature of academic content in science with students' culture and language to make instruction relevant and meaningful for their students.

The observation protocol is an adaptation from several innovative studies and ongoing projects. It combines two major efforts. First, the science instruction component is mainly based on the Miami research team's protocol which borrows from three sources including: (a) the scales for authentic instruction and the scoring of student work developed by the Center for Organization and Restructuring of Schools at the University of Wisconsin Madison; (b) the classroom visitation scales developed with Lisa Adajian in the National Center for Research in Mathematical Science Education at the University of Wisconsin Madison; and (c) the classroom observation guideline in science instruction for ethnolinguistically diverse students developed by Okhee Lee at the University of Miami. The second major influence draws from ongoing work led by Kris Gutiérrez in the University of California Los Angeles (UCLA) through her development of the Social Organization of Learning Protocol (Gutiérrez 1994).

2.1 Protocol domains

During a select sample of classroom observations, the COP scores build from field notes describing classroom activities, academic tasks, and teacher to student /student to student interactions. The protocol examines the following seventeen domains.

Science & Mathematics	Cultural Responsiveness
1. Basic math skill instruction 2. Locus of authority 3. Scientific understanding 4. Scientific inquiry 5. Scientific discourse	6. Cultural diversity as a resource 7. Modification of curriculum
Linguistic Scaffolding	Literacy Scaffolding (e.g. expository writing)
8. Use and respect of home languages for instruction 9. Linguistic scaffolding (teacher to student) (student to student) 10. Expansion options 11. Speaker designation 12. Teacher's response to student contributions 13. Use of multiple codes/code switching	14. Conventions addressed 15. Style/Voice addressed 16. Organization addressed 17. Discourse of science inquiry addressed

The domain areas are distributed unevenly and with greater emphasis on linguistic and literacy scaffolding domains that constitute10 of the 17 domains. However, these domains do not stand alone and are mutually constitutive. The protocol consists of five science and math domains, two cultural responsiveness domains, six linguistic scaffolding domains, and four literacy scaffolding domains. Scores are rated on a five point scale with a score of 5 representing more developed or extensive use of those particular domains.

The scales attempt to represent diverse classroom occurrences with often changing pedagogical goals and students' prior experiences. They also represent a snapshot of the use of a concentrated range of possible instructional supports and activities or learning structures observable in classrooms. One of the strengths of the protocol is to capture comparative data on changing and developing classroom practices across highly linguistically and culturally diverse student populations. Lastly, classroom protocol observation scores are supplemental augmentations of the qualitative findings made during weekly classroom observations over the course of three months in the spring of 2002 and after an initial three months of observation in the fall of 2001. The 22 one hour classroom protocol observations constitute a fraction of the hours (approximately 5%) spent in the field supporting classrooms and developing school/teacher partnerships, and of the entire body of classroom field notes.

2.2.COP results

The means for the four domain areas range between 2 and 3 points with SM at 2.9, C at 2, LGS at 2.6, and LTS at 2.2. Consistent with qualitative findings, protocol scores indicate that classrooms had difficulty bridging science inquiry lessons both with home or non school cultural experiences and with particular literacy goals. Domain 7 under the area of cultural responsiveness (integration of student cultural experiences into the curriculum through supplemental artifacts/materials) consistently received the lowest mean score of 1.91 (55% of the observations were given the score of 1. However, domain 13 (use of multiple codes/languages) received the second lowest mean at 1.95. Domain 6 (use of culture as a resource) averaged a score of 2.05. Domains 14 (conventions addressed) with a mean of 2.05 and domain 15 (style/voice addressed) with a mean of 2 were similarly coupled within the same area under literacy scaffolding. We found that students of linguistically and culturally diverse backgrounds often understood their role in activities but that their cultural and linguistic backgrounds were not necessarily a visible part of the classroom pedagogical approach. Roles were often reinforced through the performance of routine classroom practices like student role rotation systems and teacher modeling/praise of appropriate student behavior. Moreover, there were infrequent instances where instructional materials were extended to connect with the diversity of local student cultural experiences. Lastly, scaffolding of writing conventions and style/voice was highly inconsistent. Teachers rarely monitored students' use of conventions or style/voice to enhance students' writing development.

The three domains that received the highest scores include domain 4 (scientific inquiry), domain 5 (scientific discourse), and domain 9 (linguistic scaffolding to enhance meaning through teacher to student or student to student interactions). Domain 4 (scientific inquiry) received the highest scores with a mean of 3.45 and with 59% of the observations receiving a score of 4 or higher. This score indicates that during the observation, there was at least one significant activity involving scientific inquiry in which a third to half of the students were engaged. This finding is not surprising given the focus on inquiry in the Matter unit. Domain 9 (linguistic scaffolding) was second highest rated domain with a mean of 3.36. This domain describes that during the observation, there was at least one significant activity (like an inquiry activity) in which teacher and students communicated at and slightly above student's level of communication with some students in small groups or the whole class as way of scaffolding for shared understanding of ideas. Finally, the mean for domain 5 (scientific discourse) was 3.09. This score indicates that classroom dialogue incorporated participants' ideas to promote improved, shared understandings of a scientific theme or topic beyond uncomplicated summative statements.

Interpreting the high ratings in the SM domains and low ratings in the C domains is not a straightforward task. We need to primarily distinguish between researcher and informant perceptions of language and culture. As researchers, we constantly struggle with the predicament of culture. From a socio cultural perspective, culture and language are ubiquitous and necessarily intersect with the all forms of activity and participation including science inquiry and literacy instruction (Engeström, Engeström et al. 1995). All forms of learning are inseparable from learning to and through culture and language (Ochs and Schieffelin 1983). A plausible explanation for the low scores in the cultural responsiveness area of the protocol may be connected with the challenge and agreement of identifying examples of where students' cultural diversity and experiences are used as resources and integrated into the curriculum. We aim to revisit the construction and implementation of the protocol as described later in the report. For teachers, it may be the case that they have more isolated and bounded conceptions of culture, learning, language, and science. Assuming that teachers know they are choosing what to focus on and what not to focus on, this might explain the gap in scoring. Another explanation might just be that teachers don't know how to integrate multiple pedagogical goals with the teaching of science inquiry. If this were the case, then a developmental model of teacher change would provide an explanation. Lastly, still another explanation might be that teachers view the SIFA materials as finely scripted with little space for adaptations and modifications.

In terms of types of instructional arrangements used in the classroom, sixteen (73%) of the observations recorded both small and whole group work arrangements being used for instruction encompassing 6 of the 8 teachers. Five of the twenty two observations (22.7%) noted entirely teacher dominated classroom learning and organization of activities, whereas, thirteen (59%) observations noted that classroom activities and roles shifted between promoting teacher dominated to student dominated or negotiated interactions.

Total scores from the four schools observed vary as low as a score of 24.5 to as high as a score of 62; yet sharp comparisons are difficult to make given that the number of teachers and the number of observations vary greatly from school to school. The variance of teacher scores across domains, especially high and low scored domains, may provide clues on the implications of the data both in terms of the collection process and the observed phenomena. Several modifications in the construction and implementation of the classroom observation will need to be made. First, team scoring across classrooms and schools must occur to increase data validity. This step will also increase the frequency and sample of scores. Redundancy in observations is possible given the manageable number of classrooms in the UC Berkeley SIFA partnership. Second, it will be necessary to explore the explanations for the wide disparity among teachers between high and low scored domains (mean 1 to 4). Although classrooms work with identical science materials, each classroom is situated in particular school contexts, with unique student characteristics, and therefore different developmental goals. That is, each classroom operates with a rich pool of cultural and linguistic resources that varies according to student populations and school program objectives. Third, micro analysis (audio and video) of classroom discourse would augment how culture and language are part of science inquiry practices. The protocol is able to capture trends of global themes but with minimal reference to the developmental dimensions of learning as it occurs. This form of data would further capture the changing moment to moment learning goals and interactions between students and teachers and among students. Finally, documenting how teachers have modified the science units, which could serve as an entry point to share back with teachers how they have adapted lessons to be more interesting and relevant for their particular classrooms. This sharing of ideas might provoke further discussions on how teachers approach linguistic and scientific discourse with their students.

The findings in both the fieldnotes and the protocol scores are preliminary and highlight possible emerging directions in many facets of these classrooms. Most importantly, we want to continue building on the existing momentum that has been created across the participating classrooms through greater collaboration with teachers and investigation of the primary research questions. We will continue to test the classroom observation protocol in order to produce more robust scores with greater reliability by coupling observations, revisiting scoring guidelines, and increasing the frequency of observation.

Some observations in the classroom observation data indicate that classrooms in our case study group that displayed the most culturally and linguistically responsive pedagogy scored the highest in promoting scientific inquiry while using unique student cultural background knowledge as a resource for instruction. The Spanish bilingual classroom is an excellent example of this trend. It appears that there is connection between promoting science inquiry and utilizing broader student cultural experiences. This practice, however, was exception among classrooms.

Based on classroom data, teacher guided instruction or peer scaffolding need to be viewed as a classroom organizing practice beyond short one time repair or correction interactions. The very nature of inquiry demands that the organization of effective learning structure be reconsidered or at least modified across some classrooms. Classroom observations of the implementation of the matter unit capture the variety of ways that classrooms conducted inquiry and created scaffolding opportunities for both students and teachers. The variety of classroom arrangements can be translated into scaffolding strategies or ways of designing interactions to fit the individual developmental needs of students.

That is, our focus has remained on capturing the types and forms of scaffolding across different contexts and goals, rather than on how students require less guidance or become more independent learners. Learning constantly requires some form of scaffolding given the persistence of asymmetry of knowledge between learners in activity. Here, we borrow from models of apprenticeship and activity theory to argue for a situated conception of scaffolding where it is ubiquitous but constantly shifting between frames of proximal development. Moreover, assuming students master particular conceptions and science skills, they will use and receive scaffolding to make continually new and more challenging meanings beyond their present levels of mastery. Changes in the observational instruments assist us in capturing the degree change of scaffolding of science inquiry, which is incomplete data right now. Unit tests, however, only capture changes in knowledge of the Measurement and Matter units, which describes change of science inquiry knowledge rather than science inquiry practice.

In terns of peer scaffolding, most of the experiments involved teamwork where students work together in groups of 3 to 4 students to conduct experiments. Expertise changed according to activities, tasks, and lesson goals. Often teachers assigned students roles like "starter", "getter", "recorder", and "reporter."

3. Conclusion

Classroom observations in the context teacher surveys and teacher interviews provide excellent examples of just how teachers viewed their role in bridging science inquiry demands of all students. First, this strand is encapsulated in the range of contrasting ways that teachers monitored student comprehension of science concepts by connecting or not connecting with student previous cultural experiences. In very few cases, teachers presented new science topics or lessons by relating it to students' prior knowledge. Some teachers would try to integrate examples from children's daily experience when explaining new concepts. However, overall we seldom observed instances where student linguistic and cultural experiences outside of school were elicited as a way to either expand notions of literacy/scientific knowledge or to enhance student understanding of classroom topics. Both domain areas related to culture and literacy scaffolding score the lowest in the observation protocol. These unfortunately are examples of missed opportunities to further contextualize experiences across subjects (math, science, literacy) and experiences (home, school, among peers). In an illustrative example, students were involved in a discussion about home cooking practices but were not allowed to expand their side talk to classroom topics. This activity required the heating of water and recording of the temperature by students. The teacher read out loud the temperature changes and asked a student to put the figures on an overhead projector and for the others to record the information in their workbooks. In between temperature checks, one student spoke out loud to another group partner on how the activity reminded her of how she made brown rice with her mother in their home kitchen. This comment started an exchange with other students about the process of making rice. However, instead of expanding on this opportunity, the teacher reprimanded the students for talking while the experiments was being executed and told students to be quiet. Interestingly, however, when asked in the post interview about the importance of linguistic and cultural experiences for teaching science, the same teacher shared this example as representative of how science lessons lend themselves to talk about home activities like making rice.

Second, the extent to which teachers modified materials and/or lessons to adapt to particular learning goals was an important consideration in shaping the observation protocol, which focuses primarily on linguistic and literacy scaffolding activities. Overall, most observations concluded that there was minimal to no modification of curriculum materials so as to integrate student cultural experiences into the curriculum through supplemental use of artifacts/materials (domain 6). This domain scored second lowest of the 17 domains. The difficulty in analyzing data across classrooms and schools lies in the predicament of the situatedness of instructional interventions (Lave and Wenger 1991). Each classroom context is organized with particular collective socio cultural resources and individual student developmental trajectories in mind. Moreover, despite the fact that teachers utilized similar science materials, observations fail to describe the changing goals of interactions within and between lessons. More strategic observations of lessons and activities will help in making comparative analysis within and between classroom interventions.

Yet, the process of intervention undertaken by teachers appears ad hoc, as it relates to second language learners, and therefore, not part of a broader pedagogical strategy that anticipates and folds into lesson activities and materials that are more inclusive of the variety of student life experiences. There is evidence that indicates that some teachers collaborated and worked closely together to implement the science units. This collaboration was not possible in schools where teachers were not as many or were more isolated physically from each other, however. This collaboration led to sharing of ideas on how to improve some lessons and extend others in order to increase student comprehension of main science concepts.

As a final point, balancing the ambiguity of student exploration and explicit teacher instruction, while conducting science inquiry, was an issue in many classrooms. A possible explanation is the fact that the science units or teaching science was new to many teachers, which added a degree of anxiety over getting the lessons implemented "correctly". Nonetheless, observation protocol scores indicated that student and teacher role continuum was evenly distributed where 29% of observations were teacher dominated and 24% of observations where a combination of both teacher and student predominance of the classroom activities. This trend bears out in the observation that 9 (41%) of the protocol observations were a mix of small group, whole group, and individual work arrangements. This data reflects observations made during the second half the school year while the matter unit was being implemented. Sustained observation during the following year will afford us the opportunity to make finer descriptions.

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