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Abstract
Transformative science educators propose critical dialogue as the vehicle to a truly inclusive education in culturally and linguistically diverse settings. However, the elements of critical dialogue tend to be elusive when we try to identify them in the perspectives and practices of elementary science educators. This multiple-case study explored definitions of critical dialogue as expressed by three bilingual elementary science teachers and examined their pedagogical practices during science instruction under the lens of existing literature on dialogic education. The findings document the participants’ attempts to ask critical questions and to utilize interactional practices throughout some of the lessons observed. The participants perceived dialogue as a teacher-directed process and adhered to cooperative learning strategies based on paired-conversations, but failed, in most cases, to extend or initiate teacher↔student or student-student critical dialogue.

Introduction
The complex process of shaping the scientific understandings of culturally and linguistically diverse students often bifurcates into paths that either relegate minority children to silent and dependent roles as learners or empower them through teaching practices that not only provide valuable scientific knowledge, but the tools to engage in dialogic exchanges (Moje, Collazo, Carrillo, & Marx, 2001; Osborne, 1998). Critical dialogue represents a conscientious instructional aim with social ramifications that calls for teachers’ art of restrain as a way to revert passive learning and teaching (Freire, 2003; Shor, 1992).

The challenge for bilingual science educators is to foster students’ active involvement in scientific knowledge construction, not only as attentive listeners, but as reflective listeners/speakers (Rodriguez, 1998). Educators at different levels have embraced dialogue through critical approaches in linguistically and/or culturally diverse classrooms (Arce, 2000; Ball, 2000; Hones, 2000). Arce’s study, for instance, examined an elementary school teacher’s application of critical pedagogy in a first-grade bilingual classroom and described how the teacher’s infusion of dialogue through questions that provoked curiosity, empathy, and social consciousness resulted in students’ development of voice. Although other empirical studies (Hampton & Rodriguez, 2005; Moje et al, 2001) argue that students’ voice is crucial in developing a space for science learning in diverse classrooms, a more systematic connection has yet to be made between elementary bilingual sci-
ence teachers’ perspectives on critical dialogue and their actual inclination to teach dialogically. To contribute to the knowledge base in dialogic science pedagogy, in this study, we seek to explore bilingual teacher’s inclinations to infuse their teaching with critical dialogue. In the following section, we discuss dialogue from a critical pedagogical perspective, the role of teachers as initiators of dialogic conversations, and scientific literacy as a capacity that entails questioning and evaluation information.

What is Dialogue?

Dialogue

Freire (2003) defined dialogue as a situation in which both, students and teachers exchange roles and learn from and with each other. Inherent in Freire’s definition of dialogue is love for the world, life, and people. However, one cannot dialogue with others, including loved ones, Freire contended, if both parties lack humility and fail to acknowledge their own ignorance. Humility and faith characterize dialogues in which all contributions are valid and can in fact be expected. Humility and faith, Mejia (2004) suggested, represent conditions that clearly distinguish a dialogue from a conversation. This openness to other people’s perspectives is embedded in the belief, or internalized faith, that others are capable of drawing their own conclusions and readings of the world. Consequently, love, humility, and faith, create trust based on the congruence between spoken words and concrete actions.

Another condition for a dialogical exchange is hope that positive change will occur. It is man's incompletion or unfinished nature that lay the foundation for the world of possibilities sparked by dialogue (Freire, 2007). Leistyna (1999) stated that dialogue must inspire students and teachers to expand and critically revisit what they know. In other words, “you can’t have a dialogue thinking that it is simply a process of turn-taking and mechanical back-and-forth!” (p. 480).

In sum, dialogic pedagogy distances itself from traditional teaching through the opportunities it provides to analyze competing definitions of similar issues (Duncum, 2008, p. 253). By placing teachers and students in positions of agency, dialogic education transforms traditional lessons into democratic educational experiences (Jackson, 2008).

Teachers as Initiators of Dialogue

Giroux (1988) suggested that critical and affirming dialogue is likely to occur within schools systems that engage teachers as reflective scholars and practitioners. The assumption that teachers can in fact orchestrate, create, design, and implement instructional changes is embedded within a perspective that views teachers as intellectuals and initiators of dialogic conversations (Shor, 1992). Critical teachers position themselves as filters of “top-down” decisions, content standards, and mandates that directly affect their students. Through her research study on the identification of pre service teachers’ strengths in reference to learning science for all, Howes (2002) concluded that educators are more likely to develop effective, inclusive science instruction when they were aware of the “role schools play in perpetuating inequitable social structures” (p. 864).

Direct access to students’ perspectives and socio-cultural background allow classroom teachers to contextualize education. These educators assume critical positions, read between the lines, perceive power implications of education reform movements, and question not only the “status quo”, but their own practices (Giroux, 1988). In doing so, they are able to perceive the dangers of becoming a humanistic teacher that neglects critical content or an advocate of critical content that follows authoritarian methods (Frankenstein, 1987). In other words, “the teaching and learning
of science ought to contain elements of action and change; learning is not just an academic task; it is about interacting with the world” (Barton & Osborne, 2001, p. 22). This interaction is political by nature. It replicates relations of power in the wider society. Peter McLaren considered that the absence of dialogic conversations revolving around power and authority during science instruction must incite teachers to question their own schooling practices including how they engage their students in the intellectual task of reading, writing, speaking, using, and producing science; in order words: becoming science literate (Barton, 2001).

Critical dialogue: Its Place in Scientific Literacy

The National Science Education Standards (NRC) define scientific literacy as a capacity, not only to pose, but to evaluate arguments. The capacity to engage in critical examination of scientific information in all its forms also implies that a student is able to “ask, find, or determine answers to questions derived from curiosity about everyday experiences.” Equally important: “Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions (NRC, 1996, p.22).

Because science is often perceived as a neutral subject, social conversations that critically valuate scientific information do not spontaneously occur in elementary classrooms (Norman, 1998; Bianchini, Johnston, Oram & Cavazos, 2003). Consequently, scientific literacy is often interpreted as a body of knowledge to be transmitted from A to B. A central position in critical education is the opposing view that knowledge is never neutral and the conversations revolving around scientific knowledge are emotionally and politically charged (Harding, 1991). Therefore, ability to describe, explain, judge, evaluate, and question information must be rooted in exposure to scientific knowledge from varied perspectives. Rather than teaching and accepting the science curriculum as objective and value-free, teachers should supplement mainstream, school, and popular knowledge with students' personal/cultural knowledge, and transformative academic knowledge (Banks, 1996). Generally, critical dialogue stems from exposure to transformative academic knowledge and materializes in the form of conversations often sparked or extended by an educator that openly challenges the official versions of what students ought to know (Shor, 1992).

This study explores perspectives and practices of critical dialogue as expressed and demonstrated by three bilingual elementary science teachers. Initially, the study, which presents a fraction of findings gathered in a larger study on critical pedagogy, also sought exploration of the participants’ own definition and description of their teaching style. This was not an intervention or participatory study, although continuous informal and formal conversations took place, transformation of participants’ pedagogical practices was not the focus of this study. The goal was to expand our understandings of the type of practices, perspectives, teacher-initiated dynamics, that impede or nurture scientific inquiry through critical dialogue in settings where linguistically and culturally diverse students are present.

Research Questions

1. How do elementary bilingual science teachers describe their pedagogical orientations?
2. How do elementary bilingual science teachers describe critical dialogue?
3. Do elementary bilingual science teachers infuse science instruction with dialogical exchanges? If so, how?
Methodology

Creswell (1998) defined a case study as a scholarly endeavor involving multiple sources of information and bounded by place, time, and activity. This multiple-case study drew data from semi-structured interviews, non-participant observations, science lesson plans, and field notes collected in 2nd through 4th grade classrooms.

Setting and Participants

The study took place at Rio Bravo Elementary (pseudonym), a dual language campus located in south Texas near the Mexican-American border. The participants included one female and two male teachers whose ages ranged from 25 to 42. All participants were Mexican-American. This multiple-case study utilized purposeful homogeneous sampling as the guiding strategy. Miles and Huberman (1994) described this strategy as an approach that provides consistency through selection of participants with similar characteristics. The participants chose to maintain their anonymity and are described as follows:

Rogelio, a trained pastor, “always had a passion to teach.” The first opportunity arrived when, upon graduating from high-school, he enrolled in the military and eventually advanced to a position where he trained soldiers in the use of equipment and technology. After completing his commitment, he joined a telecommunications corporation where once again he “started at the bottom and eventually became the leader of a group and began to teach them.”

Later, at age 31, Rogelio obtained a bachelor’s degree in theology from a private Christian college and made plans to return to the education field. In 2006, he joined the “Teach for America” organization and acquired probationary certification through an ACP (Alternative Certification Program). His teaching career as a 4th grade teacher in the public elementary schools of South Texas began in a rural dual-language campus where he identified with the predominantly Mexican-American student body. “I enjoy working with the kids,” he explained, “I see myself in these kids…I grew up in a little ‘ranchito’; a small house on blocks.” When describing his pedagogical style Rogelio pointed out that:

“My teaching style, I guess, is very instructional based. I do a lot of lecturing. I incorporate as much hands-on as I can with the technology that we have today. I spend a lot of my time right in front of the Smart-Board, and with the Smart-Board I do a lot of my work.

Daniel, an experienced 41 year old teacher, started his teaching career in 1984 at an adult learning center where his father earned his General Educational Development (GED) certificate. “I could have worked anywhere,” he added, but he selected this school “because it was like payback.”

During that time, Daniel completed a degree in business and administration at a local university. Upon graduating, he continued teaching adults for a period of 12 years and in 1996, he obtained a probationary teaching certificate through an alternative certification program and signed his first contract as a kindergarten teacher.

Last year, after 11 years in an early-childhood classroom, he was assigned to teach third grade and for the last five years he has combined classroom teaching with a summer school assignment at a local church. “I give a reading class for eight weeks, but it is not the pay,” he explained. “It is something that you give back”. Daniel favored a hands-on teaching approach and advocated for differentiated instruction through direct experiences and exploration:
I see how they (children) struggle, and the difference on how the boys and the girls learn. The girls catch the reading easy. The boys need the manipulatives, so my style is get the manipulatives first, and let’s work and let them get a sense of it, get all the cognitive, and then build on it… I try to have fun and little by little adding the substance.

**Alma**, a 25 year old second grade teacher, graduated from a traditional teacher preparation program at a local university in 2005. She grew up in the rural areas of South Texas and accompanied her mother in her journey in search of jobs picking crops up North. “We would change houses a lot,” she explained. “It was very hard because we had to start all over again.” Moved by the desire to stay close to home, Alma accepted a position as a bilingual teacher at Rio Bravo Elementary.

Alma’s early experiences as a daughter of a migrant worker inspired her professional dreams and her determination to teach children of similar background. “I had friends who only spoke Spanish and they couldn’t do the work so most of the time they failed,” she commented. Faced with the need to translate for her parents and help her non-English speaking classmates during her elementary school years, Alma decided to become a bilingual educator. Last year, she volunteered to teach the second grade Spanish curriculum which included language arts, science, and social studies. Student interaction, in her view, led to increased comprehension in spite of language barriers:

For science, I believe in a lot of cooperative learning. Kids need to interact with themselves and the group to be able to understand, especially since we have both, English and Spanish, and a lot of times is very hard for the English students to be paying attention to me for a long time, so I let them work together, and you can hear it; they start explaining to each other.

**Data Collection and Analysis**

Data sources included semi-structured interviews in which the first author explored the teachers’ description of their teaching style and their definition of critical dialogue. Participants then illustrated with specific examples the type of interactions and environment that could be found in a critical teacher’s classroom. Additional instruments included detailed field notes, lesson plan samples as artifacts, and non-participant observation data. I transcribed interviews and processed data through coding during single case analysis. Maxwell (2005, p. 96) proposed coding as the main categorizing and analytic strategy in qualitative research and defined it as a strategy that “applies a pre-established set of categories to data according to explicit, unambiguous rules.” Initially, this multiple-case study focused on teaching style, critical thinking, and dialogue. Later, during the multiple-case analysis, I determined the dominant themes and constructed the conceptual framework as it related to critical dialogue. This analysis identified the threads that ran through all cases and emerged as possible answers to the research questions.

**Trustworthiness of the Study**

In order to ensure accuracy in descriptions and interpretations, the three participants of this multiple-case study reviewed and commented on interview transcriptions and information recorded in observation forms. By combining and comparing teachers’ perspectives on critical dialogue, with direct observations of their behavior during actual science instruction, their plans for lessons delivery, and field notes, I gained a better understanding of bilingual teachers’ “theory-in-use” (Maxwell,
2005). Through triangulation by method (this case study combined observations, interviews, and document analysis), I attempted to achieve corroboration by purposely ensuring that data did not contradict itself (Janesick, 2000).

The next section will present results of initial and follow-up interviews and classroom observations. In our analysis of lesson plans, we looked for evidence of purposeful attempts to incorporate dialogue into instruction. This process allowed the researcher to draw conclusions.

**What do bilingual science teachers know and understand about critical dialogue and how do these perspectives match with the views of critical scholars?**

There was little evidence that the three participants had been exposed to critical literature throughout their academic preparation. Their views on critical dialogue centered on the term “critical” stressing its cognitive meaning, but leaving out the socio-political dimensions of the word. Two themes emerged from the conversational exploration of teachers’ definition of dialogue: its description as a teacher-directed process, and the participants’ view of student-student interactions as key factors in dialogical exchanges.

**Dialogue as a Teacher-directed Process**

Critical theory proposes that active transformative learning occurs through purposeful infusion of democratic pedagogical practices in the classroom (Leistyna, 1999). Specifically, some scholars view the teacher’s role as one that authorizes students’ perspectives ensuring that “there are legitimate and valued spaces within which students can speak” (Cook-Sather 2002, p. 4; Osborne, 1998). In Alma’s words:

> The teacher would just serve as a facilitator I guess; walk around, answer any questions; be able to sit down and ask the students: “OK explain to me what you are doing”, so that you know that they are on the right track. Don’t let them do whatever they want either because your role as a teacher is to know that they learn what you are teaching, but they are able to explain to you what is it that they are doing; justify what they are doing…They can provide an explanation in regards to what they are doing and there can be a negotiation, but if they do not know what they are doing, of course you as a teacher need to try to guide them to get them back into track.

Alma’s view of dialogic pedagogy as a non-permissive approach closely coincides with Ira Shor’s perspective that empowering education “does not mean students can do whatever they like in the classroom, neither can the teacher do whatever she or he likes. The learning process is negotiated, requiring leadership by the teacher and mutual teacher-student authority” (Shor, 1992, p. 16). Contrary to Alma, who perceives the need for teacher intervention as a facilitator, Rogelio visualizes himself as someone who says the final word after student-student dialogue:

> They would not be talking about just one specific thing, they would be questions like“ what happens if we do this... what if ....and just continue to say” Let’s try this and this” until they run out of ideas as to what to try, and then they can raise their hand and say: “We don’t have any other ideas, can you come and see if any of the ideas that we have work or we are on the right track.
The absence of negotiation in Rogelio’s description of dialogue situates students’ as mere receptacles of teachers’ knowledge. “True dialogue,” Freire contends, cannot exist unless the dialoguers engage in critical thinking” (p. 92), which deeply differs from a position in which the educator imposes his/her view of the world. Daniel, on the other hand anticipates affective connections among his students and expects that student-student dialogue will lead to re-evaluation:

*Well, I expect them, first to help each other. Next, they need to give their opinion, their sense of it and then come to an understanding because one student could have the wrong concept, and the other person could have it right, so the second one will correct the first one, so they gain more knowledge from the other students, and I can teach it one way and the student can catch it, and he can talk to the other bilingual pair and say: “look, look, this is what he is doing” and they go like :”Oh”, because for them it is at his level”*

Ultimately, it is the educators’ predisposition and attitudes towards dialogue what determines the type of interactions present in a classroom (Duncum, 2008) . A positive predisposition for dialogue, coupled with humility to accept and acknowledge competing definitions, explanations, and understandings of the concepts discussed pave the way for student agency in knowledge construction (Freire, 2003).

**Student-student dialogue**

Although a second identifiable theme among all three participants was the perceived need for student-student dialogue, the absence of teacher↔student dialogue represents a topic of concern. As a democratic process, dialogue flows ‘horizontally’, establishing dynamics in which negotiations occur mutually and along a continuum in which education is carried by the teacher with the students (Freire, 2003; Shor, 1992). Through these negotiations, teachers construct pedagogies that involve critical analysis. In other words, it is not about telling students whether their views / ideas are right or wrong. Dialogic pedagogy Kincheloe (2007) asserts, moves students “to learn what they don’t know and to identify what they want to know” p. 20. In an attempt to document the extent to which dialogical perspectives translated into instructional practices, we now present an analysis of the participants’ delivery of science instruction. Initially we identify opportunities for critical thinking by including samples of questions asked. Later, we identify dialogue or potential opportunities for dialogue within the context of the science lessons observed.

**Dialogue in Practice?**

Science education, as a socially and culturally situated endeavor does not stand alone, it must be analyzed in the context of who the students are and the environment in which they learn. Kincheloe (2007) suggested that context is key in understanding the complexities embedded in knowledge construction. In this section, we present a brief glance at the instructional environment as documented through field notes. This section identifies problem posing situations embedded in the lessons observed and categorizes them as opportunities for critical thinking.

**Rogelio**

Rogelio’s classroom arrangement remained similar during the two lessons observed. Two pathways between desks allowed for student travel. Desks were arranged so students faced the front of the classroom where the teacher positioned himself. There were no examples of student generated print; science materials were lacking and there was no evidence of previous science
projects. The first lesson observed was introduced through a power-point presentation titled: “What resources are there on Earth?” and the second one elaborated on the water cycle.

**Opportunities for Critical Thinking.** During the first lesson observed, Rogelio asked questions such as, “What can happen if non-renewable resources are consumed rapidly?” eliciting evaluative and analytical judgment. Wait-time after formulating a question amounted to less than two seconds. Although Rogelio stimulated problem solving and critical thinking, he did not develop these skills during this lesson. In the second lesson Rogelio emphasized convergent thinking by asking students to recall information, remember facts, and understand the meaning of precipitation, condensation, evaporation, and transpiration. He evaluated students’ understanding and their mastery of essential skills at the knowledge/comprehension level with these questions like: “How are clouds formed?” “What causes the water cycle?” “Where does water collect?” and “what does inhospitable mean? Questions, as observed in the second lesson, remained at the knowledge/comprehension level in the cognitive domain.

**Dialogue.** The first lesson observed was the middle part of a unit on natural resources and Rogelio followed an expository pedagogical trend. In establishing himself as the predominant source of knowledge, Rogelio delivered, explained, and formulated the questions around which dialogue revolved. Although the 45 minute lesson focused on a topic of which students were likely to have prior knowledge and experiences (natural resources), neither the teacher nor the students elaborated.

Rogelio expressed his confidence in students’ abilities through expressions such as: “It is very possible that some of you will find ways to save energy. How will you do it?” This statement was followed by students’ suggestions, such as: “We could use a complete piece of paper to write on until no more space is left.” Although the teacher answered affirmatively, there were no further discussions. At the conclusion of the lesson, another opportunity to initiate dialogue occurred when the teacher challenged students to discuss three questions: “What can we do in this classroom to conserve natural resources?” “What can you do, today, in your life to save natural resources?” “What will you do in the future to save natural resources?” Rogelio’s pedagogical dialogue regarding these questions emphasized content in the form of a power point review. Transition to a subsequent stage of critical analysis was not carried through within the remaining five minutes of instruction. In all cases, discussion remained teacher-centered. In other words, critically formulated questions did not lead to critical dialogical exchanges.

Teacher-student and student-student dialogue was absent in Rogelio’s second lesson. Although during the interview Rogelio explained that he generally placed “two strong people in between three weaker people,” and they interacted “sideways,” he did not encourage such interactions. Because Rogelio spent 25 minutes talking or reading the power point slides, teacher-student or student-student dialogue was overcome by teacher presentation characterized by explanations and review of key vocabulary.

**Daniel**

Daniel did not use the district adopted textbook. He supplemented the first lesson with a battery-powered light bulb, white balloons, a globe, permanent markers and the Smart Board. On the screen he wrote the first question for discussion: “What gives us day and night?” In the classroom’s walls, there were samples of completed math worksheets, two math posters, and a calendar
marked with the students’ birthdays. Most student desks formed clusters of four with some desks individually placed next to the library center.

**Opportunities for Critical Thinking.** During the first lesson observed, Daniel used questioning techniques infused with open-endedness. Rather than lecturing, he introduced the concept through questions and asked: “What gives us day and night?” “How do you know?” “Why does the sun rise in the East?” “How do we know?” Wait-time after posing questions averaged three seconds and students were expected to verbalize their reasoning. “I want you to talk to your partner,” he insisted. “Tell your partner what you think.” Multiple conversations emerged as students analyzed the questions and drew conclusions.

During the second lesson and contrary to the first lesson observed, Daniel introduced this lesson with a teacher-led discussion while students sat and listened. Wait time averaged less than two seconds, thus providing insufficient time for discussion. Then, he posed the following open-ended questions and asked his students to think about them,

- Why is there life on earth?
- Can another planet have life?
- What makes it possible to have life?

Although the questions sparked some student comments, Daniel acknowledged only a few of those responses by integrating them into the discussion after writing them on the Smart Board. In some instances, Daniel provided evaluative comments such as: “I like your idea” “Good thinking. Let’s talk about it.”

**Dialogue.** Although teacher-generated questions dominated Daniel’s first observed lesson, he encouraged student-student dialogue through the use of bilingual pairs or pair-assisted learning techniques. Each pair of students manipulated a balloon and made it rotate and translate around the Sun. “Is it possible for the entire planet to have sunlight at the same time? he inquired. “Talk to your partner.” Students used their balloon to visualize the Earth in relation to the Sun as they discussed and formulated their responses.

In his second lesson, Daniel lectured for 10 minutes during which he explained that he expected all students to become experts in an assigned planet. “You will do research, learn about a planet and debrief,” he explained. “Everybody is going to learn from everybody.” Then, he read a segment of the book, closed it, and produced a written summary. Bilingual pairs received a book, and each student took turns reading, rephrasing, and summarizing. In this context, students were expected to take turns reading a paragraph, take turns paraphrasing or summarizing the paragraph, and checking each other’s work.

**Alma**

The physical environment in Alma’s classroom displayed signs of a dual language setting. A variety of items were labeled in English and Spanish and a science bulletin board contained student work from a previous science lesson. Seating patterns were designed to promote student interaction. Students sat in clusters of four, where two bilingual pairs faced each other throughout the lesson.

**Opportunities for Critical Thinking.** Although Alma implemented a question-driven science lesson, the levels of thought required of the students targeted basic/factual knowledge. Students answered in short statements when asked: “Why is the Sun important?” and teacher replied with brief
affirmative responses such as: “yes” and “uh-huh.” Examples of questions posed by Alma:

- What is the solar system?
- What planet is this one?
- Does the moon stay or does it go away?
- How long does it take?
- What can we find in the solar system?
- Why is the sun important?
- How many planets are there in the solar system?

The topic of Alma’s second lesson generated multiple instances of student verbal output. Although student discussions and comments dominated the lesson, Alma posed a variety of open-ended questions that began with the use of a concrete object as a focusing activity in which an artificial and a real plant were held in front of the students. After asking: “What do you know about living things? What can you tell me about these two plants?” students began analyzing their distinguishing features. Then Alma challenged students to think of ways in which humans and plants needed each other. Other questions posed included: “What do you know about plants?” “What do we do with plants?” “What is the job of the root?” “What is the job or function of the stem?” “Are plants living things?”

Dialogue. Alma’s science lesson transitioned from a teaching section to an independent practice stage. While teaching, Alma’s wait time after asking questions was one second. All questions were posed openly with no particular system implemented to ensure all students’ participation. Although Alma advocated for the use of assisted pair learning or bilingual pairs to maximize concept mastery and language development, students sat in groups but worked independently.

In one instance, Alma integrated a student’s response to a question and utilized it to connect the content of the lesson. In the student’s opinion, there was an important reason why countries do not receive sunlight at the same time: China, for example. Alma acknowledged her comment, asked her to explain her thoughts and illustrated this concept with a light bulb and a globe.

Alma established several conditions for dialogue in her second lesson. Throughout her initial introduction and explanation of the concept, she incorporated students’ input and prior experience to the discussion. Their contributions ranged from what they see in their homes’ gardens to connections with plants and foods they have eaten at home such as cactus and jalapeño peppers. After reviewing the parts of a plant, one student commented: “Miss, did you know that we make the carbon dioxide that the plants need?” Alma acknowledged and elaborated on the student’s statement to address other functions of the plants. “Yes, and what do they produce that we need?” Afterwards, she asked, “How does this happen?” In general, pedagogical dialogue centered on students’ prior knowledge in connection with the concrete objects presented in class.

Although two science lesson plans per participant were collected, the first author found no significant data that could be coded or analyzed for the purposes of this study. Lesson plans in this campus follow a district determined format which leaves little or no room for elaboration or teacher input.
Discussion/Conclusions

The participants’ instructional practices in the context of science education must be dissected, not only in terms of manifestations of critical dialogue documented in the lessons observed, but in light of two limitations:

1. Actual time dedicated to science instruction. On this campus, emphasis on reading and math instruction determined teachers’ daily schedules. Science instruction had either been reduced to 90 minutes a week or had gradually been implemented on a “homework basis” in some classrooms.

2. Limited access the school’s science lab. Because only 5th graders are evaluated by the state in the area of science, use of materials and science lab facilities was often reserved for 5th grade science sessions during the second semester of the school year.

One lesson learned from these case studies was that, consistent with Ruiz and Fernandez-Balboa’s (2005) research on physical education teachers’ perspectives on critical pedagogy, the participants’ interpretation of critical dialogue was personal, not academic. These bilingual educators defined critical dialogue by relating it to their own practices and reverting to the types of pedagogies or instructional practices that they know best. That is, they emphasized cooperative learning strategies, specifically the use of peer learning or ‘bilingual pairs”, and the use of critical thinking skills.

We also learned that, in practice, critical thinking was an elusive component of all science lessons observed. Although Rogelio adopted a problem posing approach when introducing the lesson on the use of natural resources by asking: ‘What can happen if non-renewable resources are consumed rapidly?’ and Alma challenged her students to brainstorm what they already knew about living things, questions seemed to follow a vertical flow (from teachers down to the students unidirectionally). Critical scholars stress the need to formulate open ended questions throughout instruction (Shor, 1992), however, open-ended tasks and questions must move beyond the capacity to function at high levels of complex thinking to include an ability to affect and effect the sociopolitical and economic realities that shape students’ lives, (Leistyna, 1999 p. 218).

Given the emphasis that two of the participants of this study placed on formulating complex questions connected to real-life issues, it was clear that the seeds of genuine dialogic conversations had been planted. Faced with such a scenario, one must ask, ‘How does one evolve from a positive predisposition for dialogue to a conscious implementation of dialogic pedagogy?,’ How can students engage in meaningful conversations when wait-time after posing a questions in the classrooms observed averaged less than 2 seconds? Asking questions or adopting a problem posing-approach are key ingredients of a participatory or inviting beginning of any lesson (Freire, 2003; Shor, 1993) but the crucial follow-up step, must be to start listening and to stop speaking for others (Delpit, 1988; Cook-Sather, 2002), especially when those ‘others’ are culturally and linguistically diverse students whose voices are marginalized by excessive teacher talk. Such marginalization includes the inability to acquire content knowledge, practice all language skills, and engage actively in science instruction as proposed by national science reform movements (AAAS, 1990). Empirical studies focusing on the disconnect between teachers’ stated beliefs and their beliefs in practice propose that researchers may have to take steps to “strongly encourage and at times di-
rectly prompt for transformative practices to take place” (Rodriguez, Zozakiewicz, & Yerrick, 2005). From this perspective, equipping teachers with more democratic pedagogies must become a priority at the level of teacher preparation programs. Specifically, science approaches courses must be redesigned to emphasize scientific literacy as a capacity or ability to engage in critical conversations (NRC, 1996).

Third, we learned that participants did not make a clear distinction between dialogic conversations and cooperative learning strategies. Whether they implemented cooperative learning strategies or not, all participants seemed to endorse interactive approaches to learning and teaching. Alma and Rogelio for example, favored the use of paired learning or “bilingual pairs”. Troubling, however, is the persistence of turn-taking behaviors in which students answer (individually or in dyads) questions at low cognitive levels. The counter-agenda for dialogic discourse proposed by Shor (1992) requires, among other things, that teachers ask thought-provoking questions; be patient and listen to students and in giving them time to think on their feet, to think in groups, to write, and to read with understanding; and seek equal participation for minority students. (p. 86)

Finally, although the participants of this study perceived dialogue as a teacher-directed endeavor, few spaces were opened for student agency in drawing conclusions or questioning information discussed. Given the participants’ perceptions of dialogue as a teacher-directed and student-centered endeavor, a challenge for teacher educators is to expand prospective teachers’ view of dialogue to include the possibility of student↔teacher dialogue. Critical dialogue, as a problem-posing approach to science education is particularly beneficial to linguistic and culturally diverse students whose views of the world, language, and culture occupy a subordinate status in mainstream society (Rodriguez, 2005; Wallerstein, 1987). By opening spaces for dialogic conversations in our own classrooms, teacher educators will have taken the first step toward a genuinely democratic perspective of science for all.
References


