What’s language got to do with it?: A case study of academic language instruction in a high school “English Learner Science” class

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Abstract

This article presents a case study of academic language instruction in a high school “English Learner Science” course. It illustrates how a teacher’s understanding of academic language affects her instruction and students’ opportunities for learning. We examine a transcript of classroom discourse for the “didactic tension” that exists between this educator’s teaching of science vocabulary and students’ development of conceptual understanding in science. We assert that the teacher’s emphasis on vocabulary serves to obscure important semantic relationships among the phenomena she is teaching about in her lesson, as well as ignores the linguistic resources needed to express those relationships. We propose that the social action accomplished by this didactic tension may be to produce an economy of discourse for English Learners which, contrary to the goals of academic language instruction, serves to withhold from them opportunities to not only to talk, but think, like scientists. We use our findings to call for further research into teachers’ beliefs, practices, and discourse related to academic language instruction and the impact of these on students’ language as well as content learning.

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1. Overview of the problem

As the student population in US schools becomes increasingly culturally and linguistically diverse, the body of knowledge and skills required to be an effective teacher is changing. The growing presence of limited English proficient (also referred to as English Learner [EL]) youth in US schools means that more teachers of core academic subjects, like science, are confronted with instructional issues related to second language acquisition. Simply put, teachers are facing the question, “What’s language got to do with it?” In this paper, we highlight the challenge one teacher faces in attempting to provide science instruction that is attentive to the needs of ELs. In so doing we hope to contribute to the emerging body of research on teachers’ beliefs, practices, and discourse with respect to integrated instruction in science (Fradd & Lee, 1999; Stoddart, Pinal, Latzke, & Canaday, 2002).

Drawing on interview and observation data from our study on explicit academic language instruction for ELs in science, we document a teacher’s beliefs about the linguistic elements of her science lessons, and describe her practices related to the direct instruction of these linguistic elements to students. We detail this teacher’s understanding of integrated science teaching with EL students and examine in what ways her understanding affects both language and content development.

2. The didactic tension between language and content development

The case we detail in this article illustrates what we regard as a “didactic tension” (Mason, 1988) between content and form in integrated science instruction for EL students; that is, the tension that exists between the goal of teaching ELs how to talk science and the goal of teaching them how to do science. Mason (1988) observed that the more explicit the attention put on form by the teacher, the more likely the form will be mistaken by the students as the substance of instruction itself (Pimm, 1994, p. 143). In the case that follows, we witness this tension when a teaching of science as vocabulary constructs the instructional environment in such a way as to constrain students’ opportunities to engage in meaning-rich discursive practices in the science learning community. The lesson we highlight about the didactic tension is the importance of providing students with information about academic language while not creating an “artificial” learning environment (Pimm, 1994, p. 144). As Roth (2005) writes, “We become competent speakers of a language when we participate in using it for some purpose rather than when we learn it for its own sake” (p. 52).

But advocates for culturally and linguistically diverse students urge us to regard explicit form-focused instruction as essential to their success in school (August & Hakuta, 1997; Colombi & Schleppegrell, 2002; Delpit, 1988). How does this recommendation impact the didactic tension? The case below warns us that teachers’ effective implementation of explicit academic language instruction may depend on what they understand “academic language” to mean. Inadequately understood as merely vocabulary, efforts to teach academic language in science are likely not to be the way to achieve productive outcomes for ELs in English proficiency nor in science mastery. In stressing the didactic tension, they may, as we will argue, constitute a classroom discourse economy that continues to defer, not improve, success for language minority youth in US schools.
3. The language of science

We began this paper by noting that teachers of ELs in the content areas are facing the question, “What’s language got to do with it?” With respect to science, the semiotic analysis and approach offered by Halliday and Martin (1993) is a useful tool in understanding the use of linguistic resources in constructing scientific meaning. It not only explains the characteristic features of scientific language but also accounts for their evolution. Central to Halliday and Martin’s treatment of science discourse is the understanding that what we recognize as the language of science is as much a reflection of the broader development of modern science itself as it is a particular representation of scientific meaning making. They detail, for instance, Newton’s use of nominalization (the conversion of a verb into a noun phrase, e.g., “separate” to “separation”) in his *Treatise on Opticks* (published 1704; written 1675–87) as an example of how early scientists used already-existing grammatical resources for “their own rhetorical purposes: to create a discourse that moves forward by logical and coherent steps, each building on what has gone before” (p. 64), thusly achieving the argumentative structure of science’s signature experimental method. In this way, scientific language developed not just as a tool for expressing scientific meaning; it played an important role in construing the possibility for such meaning.

A result of the nominalized nature of scientific language is lexical density (understood as a high number of lexical items per clause). This sheer density, as Halliday and Martin point out, makes comprehending scientific text difficult. Further, nominalization creates “a whole new realm of experience” in which concrete processes, previously represented by verb phrases, become, in their conversion to noun phrases, “abstract theoretical entities” (p. 18), thereby tending to “leave implicit the experiential meanings that they most depend upon” (p. 68). Comprehending such constructions is a challenge for all learners, they acknowledge, and they emphasize the utility of trying to see scientific language from the learners’ point of view in order to facilitate effective instruction (p. 68). They lament, however, that most science teachers conceive of scientific language instruction in terms of vocabulary only (p. 70).

Wignell, Martin, and Eggins (1993) observe that one way this emphasis on vocabulary manifests itself is by teachers’ signaling scientific terms through a variety of techniques. The signaling of these terms speaks to the importance in the sciences of observing, classifying, and explaining phenomena; scientific terms are used to “order the world” into taxonomies that characterize particular areas of science. But, as Wignell et al. note, while teachers make the scientific terms explicit through signaling, often the very taxonomies and complex relationships of phenomena of which they are a part remain implicit (p. 165). To return to Halliday and Martin, “Scientists do not simply organize things … They are also concerned with processes” (1993, p. 177, our emphasis). Thus, efforts to facilitate the instruction of scientific language that mistake familiarity with discrete vocabulary for knowledge of the larger framework of processes to which the vocabulary refers are inherently misguided and may lead to the formation of an educational community that is perhaps more hobbled than it is helped by the goal of explicit academic language instruction. Observing the dynamics of a science classroom that has as its objective the teaching of academic language affords the opportunity to examine the kind of educational community that forms through such instruction and to expose the gaps that may exist between that institutionalized school discourse and the larger social practice of science.
4. Semiotics and a sociocultural understanding of integrated instruction in science

The appropriate use of linguistic resources in science, as Lemke (1990) importantly notes, is more than just talking science; such use is inherent to actually doing science. Therefore, learning the language of science is an essential feature of being identified (by oneself and by others) as one who does science, that is, as one who is a “scientist.” The relationship between language (form) and content (meaning) and the role of that relationship in the formation of [science] community, has been captured by principles of social semiotic theory (see Lemke, 1990, pp. 183–213 for a helpful overview).

Viewed as a semiotic resource system, language can be characterized as a basic set of rules that encompasses one’s knowledge about what can be said and how to say it. Viewed, alternatively, as a set of semiotic formations, language can also be characterized as the choices one makes in construing meaning (Halliday, 1978). These choices reflect one’s knowledge about what repeatedly does get said in particular settings, how it gets said, and to what intended effect (Halliday & Martin, 1993; Lemke, 1990). Importantly, semiotic formations differ from community to community. As Lemke (1990) states, “[a] community deploys its semiotic resources in certain habitual ways, and these are its semiotic formations. A formation is a sort of ‘institutionalized’ way of talking, gesturing, or behaving” (p. 194). For youth in school, academic success, then, depends on the extent to which they are able to master the “institutionalized” semiotic formations of a variety of communities, their science classrooms being one of those. Such mastery is a challenge for all students, but it is especially challenging for students for whom English is a second language because these students are still in the process of acquiring the semiotic resources (the basic rules) on which a community’s semiotic formations depend.

Furthermore, because of the nature of educational services provided to them because of their limited-English-proficient designation, EL students often learn academic content as part of communities that do not provide them with exposure to the same kinds of semiotic formations to which their proficient English-speaking grade-level peers are exposed, formations that would more closely match what is expected in demonstrating grade-level achievement in a content area. Nearly 50% of US public schools, for example, report servicing their EL students through instruction geared “to below age-appropriate levels” (National Center of Education Statistics, 1997, p. 15).

Thus, the key to productive integrated instruction, if it is indeed to narrow the achievement gap, is to provide EL students with input and output opportunities that mirror the kinds of semiotic formations upon which mainstream (normative) performance expectations rely. If this is not accomplished, teachers may interpret EL students’ lack of familiarity with the linguistic properties of scientific “reasoning” as difficulties in the cognitive processes themselves (Christie, 1999). This may, in turn, affect expectations for learning, plans for teaching, and ultimately, student engagement and achievement in science. The academic language of science is part of the hidden curriculum that can apportion privilege to those with access to its rules and penalty to those without (Cazden, 2001; Christie, 1985). In this way, as Lemke points out, the semiotic formations of science instruction result in discourse that is inevitably performing a social action. A sociocultural, semiotic perspective, as Luke (1993) says, provides us a view of science “not as a mental accomplishment but as social and textual practice.” It reveals the “political economy of discourse” at work in science teaching and learning (p. xiii).
On the one hand, the call for integrated instruction in science is certainly the result of a growing awareness of the workings of such a discourse economy in science. It acknowledges that students who speak English as a second or additional language may be at a decided disadvantage in comparison to their native, monolingual English-speaking peers. Thus, professional development efforts now specifically target the enhancement of science teachers’ knowledge and skills in integrating language and literacy goals into science instruction and researchers document the challenges that exist in changing teacher beliefs and putting these beliefs into practice (Hart & Lee, 2003; Lee, 2004; Lee, Hart, Cuevas, & Enders, 2004; Stoddart et al., 2002). On the other hand, however, the call for integrated instruction is certain to affect the economy of discourse in science classrooms with ELs in ways that themselves merit examination. In other words, what does a teacher’s ideas about integrating language goals “do” to science instruction? What might be the social action performed by the discourse economy that results from the goals of integrated instruction?

5. Methodology

The case we report on here is part of a larger exploratory study examining explicit academic language instruction in science classrooms. In this study, we were interested in documenting how teachers’ conceptualizations of academic language were implemented in their science instruction and to what effect. Over a 4-month period, we interviewed teachers and observed instruction in seven Iowa classrooms. Here we present data we gathered from one of these sites, a 9th-grade all-EL science classroom.

The data we use here comes from the teacher interview we conducted before our first visit to the classroom and from the classroom observation we performed during the first visit to this site. Drawing on these teacher interview and classroom observation data, we developed a “case” (Goode & Hatt, 1952; Strauss, 1987) that describes the teacher’s practice of academic language instruction and captures the effect of those beliefs on student language and content learning. Our presentation of the data as a “case” is meant, as Goode and Hatt explain, “to preserve [its] unitary character “(p. 331) and thus focus attention on the details of the case, rather than claim generalizability to all science teachers and classrooms. Such generalizability at this early stage in our research is unjustified; however, the case does raise significant questions about the impact of explicit academic language instruction on opportunities for conceptual development for ELs in science classrooms that deserves examination. We hope our discussion will be useful to others invested as either researchers or teachers in issues related to the science education of EL students and we aspire to that goal as a measure of our work’s validity (Lather, 1991).

The case we present is informed by an approach to analysis strongly influenced by Lemke (1990, see Appendix, pp. 215–232). We first transcribed the videotaped classroom observation, and next, reviewed the classroom transcript for:

1. the instructional segments of the lesson (i.e., its Review/Motivation, Information, Practice, and Application/Review phases);
2. the activity types used in the lesson (teacher exposition, triadic dialogue—a teacher initiation–student response–teacher evaluation sequence, group work, etc.) and teacher–student control strategies (admonitions, asserting irrelevance, disengagement, etc.).
the semantic relations inherent to the lesson’s overall thematics (nominal, taxonomic, transitivity, circumstantial, and logical relations); and

(4) the teacher–student thematic development strategies (selection and modification, foregrounding and backgrounding, glossing, repetition with variation, marking old information, etc.).

In this review, we paid particular attention to where and how in the transcript the teacher signaled academic language (usually through verbal discursive metacommenting strategies, i.e., “what’s that called?” and phonological strategies, i.e., word stress). Once identified, we watched the videotaped segments of explicit academic language instruction again to record the teacher’s writing activity at the white board and how those visual data corroborate the verbal data (Kress, Jewitt, Ogborn, & Tsatsarelis, 2001). We use information gleaned from all aspects of this analysis to construct a contextualized narrative account of the rock cycle lesson we observed in this “EL Science” classroom. In particular, we supplement our narrative account with figures representing the visual information that was being constructed on the white board at various points in the lesson as well as with a thematic diagram (following Lemke, 1990) providing an overview of the lesson’s scope. We found this form of diagraming helpful in focusing our attention on the (dis)connect between what the teacher explicitly taught as academic language (her focus on form) and the implicit semantic relations that characterize the thematics of the science lesson (the content).

6. Linda’s case: “what were the two parts for how?”

Linda Crabtree teaches in Captainville, Iowa. She is one of 26,000 people that live in a city transformed by a globalized agri-foods industry. Over the last 10 years, 13% of Captainville residents have come to be Latino, the majority Mexican or of Mexican descent. This is because Bensen, a major meat-processing plant located in Captainville, attracts immigrant Mexicans to meet its demand for willing and inexpensive labor. As a result of a decade’s demographic shift, Captainville schools are facing instructional challenges many other Iowa schools have not yet faced. Eighteen percent of the otherwise predominantly white (77%) student body at Captainville High School is Latino, a figure nine times the state average. Of total enrollment, 13% are designated ELs (overwhelmingly from Spanish-speaking households).

In 2003–04, the achievement gap between white and Latino students increased at Captainville and was a noted area of concern for the district. Only 23% of Latino students, as opposed to 77% of white students, were assessed as proficient in reading comprehension. A similar gap existed for science proficiency as measured by the Iowa Test of Basic Skills (ITBS) (Captainville Community School District Annual Progress Report to the Community, 2003–4).

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1Nominal semantic relations include those of attribution, classification, or quantification. Taxonomic semantic relations include those of hyponymy, meronymy, synonymy, and antonymy. Semantic relations of transitivity include those related to agent, target, medium, beneficiary, range, identification, and possession. Circumstantial semantic relations include those related to location, time, material, manner, and reason. And logical semantic relations include those related to elaboration, addition, variation, and connection. See Lemke, 1990, pp. 221–224.

2The teacher, school, and community names we use are pseudonyms.
It was Linda’s Spanish ability (albeit limited) that got her the job at Captainville. She moved to the community 11 years ago after having taught 11 years previously in another (non-EL) Iowa context. Her professional training as a teacher did not prepare her for work in an EL science context. She was not specially trained in the content area of science nor in work with bilingual or ESL populations. As she put it, she has taken “some courses” on instructional strategies for EL students.

The course she teaches is a general “EL Science” course that is intended to prepare students for “regular” (non-EL) Earth Science the following year. Linda remarked that Captainville teachers have found that many ELs are not successful in Earth Science because they do not have the necessary vocabulary. “By having this general EL Science course,” Linda explained, “we use the vocabulary and help them to prepare for going into the regular classroom.”

Linda’s stated goal, then, is to teach her EL students the scientific language they will need to succeed in a mainstream science setting. Linda’s understanding of what they will need is clearly influenced by a view of language-as-vocabulary. In providing a description of how she teaches academic language in science, Linda says academic language for her is about building vocabulary. About her unit on the rock cycle, she said, “Once in a while I’ll say ‘group’ the rocks and then I’ll say ‘classify’ the rocks and I keep using those science terms.” This statement exemplifies the vocabulary-driven conception that Linda has of academic language. Below, we describe what that conception looks like put into practice.

6.1. The rock cycle lesson

The first lesson we observed Linda teach was a lesson from her unit on the rock cycle. In her introductory Motivation/Review phase of the lesson, she summarized material they had already covered about the different types of rocks, focusing on making sure students understood the classifications of “igneous,” “sedimentary,” and “metamorphic” rocks. She did this by drawing a three-columned figure on the white board with the respective labels “Igneous,” “Sedimentary,” and “Metamorphic,” and asking students to tell her “one thing” about each type of rock. The exchange that follows is typical of the triadic dialog (the teacher initiation–student response–teacher evaluation sequence) that made up her Review:

1 Linda: Tell me one thing [holding up one finger] about an igneous rock
2 …dime un cosa de los igneous rocks
3 Augusto: I know … they came from the volcanoes
4 Linda: Which part of the volcano?
5 Augusto: The bottom
6 Linda: What’s that called?
7 Augusto: Magma [magrant] with Spanish pronunciation
8 Linda: MAGma [magrant] stressing English pronunciation
9 Students: MAGma [magrant] repeating English pronunciation
10 Linda: [writing “magma” on the board under Igneous] At least that’s what

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3When necessary, translations of Spanish statements appear, italicized, in parentheses. Here and elsewhere, Linda translates her own English statement into Spanish for the students. Throughout the text, errors in Linda’s Spanish have not been corrected.
11 we’re thinking for now… How about sedimentary? Tell me one thing
12 about sedimentary
13 Female Student [Off-camera]: Fósil [fósil] saying ‘fossil’ in Spanish
14 Male Student [Off-camera]: Fossil [ˈfɔːsil] approximating the English pronunciation
15 Linda: I couldn’t hear you
16 Female Student (Off-camera): Fósil [fósil] repeating the word for ‘fossil’ in Spanish
17 Male Student [Off-camera]: Fossil [ˈfɔːsil] again approximating the English pronunciation
18 Female Student (Off-camera): Fossil [ˈfɔːsil] approximating her pronunciation to her classmate’s
19 Linda: Oh, there are FOSsils in there, right … and how do those fossils
20 get there? [writing ‘fossil’ on the board under Sedimentary] Because
21 there’s what? [moving hand back and forth horizontally through the air]
22 Male Student [Off-camera]: (inaudible)
23 Linda: How do they get in there?
24 Male Student [Off-camera] Student: (inaudible)
25 Linda: Cómo, cómo los animales está (Like, like the animals are) … [moving one folded arm up and down over the other]
26 Male Student [Off-camera]: Sepultados (buried)
27 Male Student [Off-camera]: right (inaudible) is dead (inaudible) lines
28 Linda: But what are those called? Yeah, what are those LINES called?
29 Male Students [Off-camera]: Lines
30 Linda: Starts with an ‘l’
31 Eduardo: Layers [ˈleɪərs] pronouncing with a Spanish accent
32 Linda: LAYers [ˈleɪərz] stressing English pronunciation
33 Students: Layers [ˈleɪərz] repeating English pronunciation
34 Linda: [writing ‘layers’ under the Sedimentary column] And who … Is
35 there anything else you remember? Is there anything else you remember
36 from sedimentary?
37 Augusto: They change … with time
38 Linda: Is that sedimentary?
39 Male Student [Off-camera]: No
40 Augusto: They become metamorphic
41 Linda: So metamorphic is change over time with pressure and heat, right?
42 Male Student (Off-camera): right
43 Linda: [writing “change over time,” “pressure,” and “heat” under the Metamorphic column]
44 Male Student [Off-camera]: Change over time with pressure …
45 Linda: Pressure and heat, right?
46 Male Student [Off-camera]: Right

Linda and one student, Augusto, begin this sequence in a teacher-student duolog focused on the idea that igneous rocks come from magma. Linda signals “magma” as a term she has identified as academic language when, using a metacommenting strategy, she asks Augusto to clarify or gloss (in line 6—“what’s that called?”) what he means by “the bottom [of the volcano].” Linda, in this way, marks “magma” as important academic language information, a move that she further emphasizes by indirectly correcting
Augusto’s pronunciation (line 8). The students then pick up on Linda’s foregrounding of the term “magma” by repeating the corrected pronunciation (line 9), which Linda acknowledges by writing the word on the board under the “Igneous” column of her chart and moving on to questioning about sedimentary rocks (lines 9–10). In lines 13–18, we see a student adapt her Spanish pronunciation of the word “fossil” to her classmate’s English pronunciation before the answer is recognized by Linda (line 19) and used as a springboard to elicit the desired response — “layers” — to the question of how the fossils “get there.” Linda uses a series of gestures (lines 21–25) to produce this desired response, working through the initial student response of “lines” (line 27) and cueing the need for a more technical term by asking “what are those lines called?” (line 28). In lines 31–33, Linda and her students negotiate the correct pronunciation of the word “layers” until Linda signals she is satisfied by writing the word on the board under the Sedimentary column and asking them whether there’s anything else they remember about sedimentary rocks (lines 35–36). When Augusto (line 37) mistakenly answers “they change ... with the time,” with Linda’s prompting (“is that sedimentary?” in line 38), he adjusts his answer to “they became metamorphic” (line 40). Linda rephrases and expands his utterance into the summary statement (line 41), “So metamorphic is change over time with pressure and heat, right?” and writes the phrase “change over time” on the white board under the Metamorphic column and, below that, the word “pressure” and then “heat.”

This excerpt exemplifies the techniques Linda used to explicitly signal and thereby teach academic language in this class. She uses a white board to record conceptual information related to the different kinds of rocks the class has been studying (rock taxonomies) and to underscore her focus on vocabulary-based academic language teaching strategies. These include the discursive strategies of metacommenting (“what’s that called?”—lines 6 and 28) as well as repetition (lines 8, 12, 19, 28, 32, 41, 45) and the (often-overlapping) phonological strategies of word stress and pronunciation (lines 8, 19, 32). What Linda writes on the white board stands as a textual record of the focal points of the lesson. Notably, it consists almost entirely of discrete lexical items (Fig. 1). This reflects her initial prompt in this sequence to have students tell her “one thing” about the categories of rocks they have been studying.

As the lesson developed, Linda brought the students’ attention to igneous rocks in particular. She taught them that igneous rocks consist of two kinds of rocks, “extrusive” or “volcanic” rocks and “intrusive” or “plutonic” rocks, and that these rocks differ in where and how they form and the characteristics produced by their processes of formation. She wanted students to understand that intrusive rocks form underground from magma and extrusive rocks form above ground from lava. She wanted them to understand that,
because intrusive rocks form underground, they cool slowly, producing large grained, coarse characteristics. Extrusive rocks, on the other hand, form above ground, so they cool rapidly and have fine grained, glassy characteristics. That was the scope of the thematic content of Linda’s rock cycle lesson. We have represented the thematic development of Linda’s rock cycle lesson, as well as its associated semantic relations, in Fig. 2.

What is important about the thematics of Linda’s lesson is the prominence of taxonomic and circumstantial semantic relations. Taxonomic semantic relations are those related to distinctions of class and category, of parts to whole. The relationship of the concepts ‘igneous,’ ‘sedimentary,’ and ‘metamorphic’ to the concept ‘rock’ is co-hyponymic; they are subcategories that belong to the same more general category. Similarly, the relationship of the concepts ‘extrusive’/’volcanic’ and ‘intrusive’/’plutonic’ to the concept of ‘igneous’ is also co-hyponymic. In terms of circumstantial semantic relations, the underlying thematics of her lesson depend on relations of location (‘above ground,’ ‘underground’), material (‘from lava,’ ‘from magma’), and manner (‘cooling rapidly,’ ‘cooling slowly’). These circumstantial relations are linked, in Linda’s lesson, to the attributes of rocks in the rock cycle in that how rocks are formed influences the way they look. These descriptive attributes are expressed through semantic relations of nominality (‘fine grained,’ ‘glassy,’ ‘large grained,’ ‘coarse’).

Expressing particular semantic relationships in science (as in other content areas) requires drawing on particular linguistic resources. For example, expressing taxonomic relationships requires the use of linguistic resources that can mark relational information (“The rock cycle involves/includes igneous, sedimentary, and metamorphic rocks” or “Igneous, sedimentary, and metamorphic rocks are part of the rock cycle”). Expressing circumstantial relationships requires the use of prepositional phrases, adverbs and other resources for marking information about time, place, and manner (“Intrusive rocks form through the slow solidification and cooling of magma” or “When magma cools and solidifies slowly it produces intrusive rocks”). Nominal semantic relations, because they mark information about descriptive qualities and this modifying function may be achieved by placing a descriptive word in front of the object being described (large grain, coarse rocks, fine grain, glassy rocks), are unique in that they require linguistic resources only at the word or lexical level. Otherwise, the semantic relations of taxonomy and circumstance, on the other hand, require linguistic resources at the syntactical or sentence level.

These semantic relations constitute the implicit grammar of Linda’s rock cycle lesson. Indeed, Linda expressed her tacit understanding of the semantic relations of her lesson.

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Fig. 2. The thematics of Linda’s Rock Cycle lesson and associated semantic relations (in italics).
when she moved out of the introductory Motivation/Review phase and into the Information phase. The words and phrases she used in expressing her objective for the lesson highlighted semantic relations of taxonomy (‘kinds’), circumstance (‘how’ and ‘where’), and nominality (‘characteristics’). They have been bolded in the following excerpt:

Linda: [pointing to the Igneous column on the whiteboard] We’re gonna talk about igneous rocks … Our objective [hitting palm of left hand with dry erase marker] … what we hope to do … las cosas nosotros quiere hacer en esta clase … [rubbing dry erase marker across fingers of left hand] is we want to be to know the two kinds … necesito saber los dos tipos de igneous rocks [holds up two fingers of left hand] … we need to be able to explain how they form [holding both hands outstretched with palms up] … como las rocas forman [lifting both hands up and lowering them]… we need to be able to list the characteristics of the rocks … que es los characteristics [pinching fingers of left hand together] … So those are the things that we need to do (using dry erase marker to tap three fingers of left hand) … Where do rocks form (moving both hands down and away)?

However, Linda’s explicit teaching of academic language does not capitalize on her tacit grasp of these semantic relations. Her instructional focus is on discrete vocabulary related to the rock cycle, not the other linguistic resources, the grammar, used to express the relationships these lexical items, as signifiers of rock-cycle related phenomena, have with one another. In the excerpt that follows, it becomes clear that Linda’s explicit academic language instruction, focused as it is on the lexical level, has the danger of “freezing” and “flattening” the semantic relations that characterize the temporal processes related to rock formation, the theme of the lesson. It takes, as we see it, the “motion” out of meaning making.

The following excerpt is from the Information phase of her lesson. At this point in her instruction, she is establishing that igneous rocks form either underground (from magma) or above ground (from lava). She has drawn a picture on the white board of a volcano and has labeled it so the word “lava” is on the outside of the volcano and “magma” is on the inside (Fig. 3).

Linda turns to the textbook and reads a paragraph out loud about the rock formation process. She uses this reference to an external text to initiate another triadic dialogue sequence that is again dominated by a duolog with Augusto:

1 Linda: Let’s look at page 215 [leaning over textbook] … Look at the formation … of … igneous rocks. [Reading from the text] “Recall that the rock forming process determines the type of rock. Rocks produced by

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4The psychomechanic model of language analysis by Gustave Guillaume (Guirard, 1970) distinguishes between preliminary paradigmatic processes (opposition between lexical entities in a language system, such as “he/she,” “can/will” and “go/run”) and secondary syntagmatic processes (opposition between entities in a linguistic chain, such as “she” + “can” + “go”). The paradigmatic processes are part of a system of virtual representation, one that is outside any real temporal dimension; the syntagmatic processes, on the other hand, are part of a system of actual temporal expression, one that allocates content to a moment of real time. In our argument that teaching academic language as vocabulary results in taking the “motion” out of meaning-making, we are asserting that students are taught the virtual (time-less and motion-less) paradigmatic oppositions, but not how to put those to use to express actual (time-embedded) syntagmatic chains.
the cooling and solidification of magma are classified as IGneous.”

[Looking up and asking the class] Igneous rocks form either UNDERground

[turning and writing “underground” under “magma” in the Igneous

column of the white board figure] or where?

Augusto: Near to the …

Linda: What does it say?

Augusto: Sea …

Students: Sea …

Linda: Or ON the Earth’s surface [writing “on the earth’s surface” under “underground” in the Igneous column]

Students: Si

Augusto: (inaudible) Two points for me

Linda: I’ll give you five points, OK, just for being here … So they …

this answers the question WHERE [drawing brackets around

“underground” and “on the earth’s surface”] … WHERE do they form?

They form either UNDERground OR on top of the earth

Augusto: But I wanna know HOW

Linda: You wanna know HOW? Didn’t we already answer how?

Augusto: (inaudible)

Linda: How? [writing “how” in the Igneous column] What were the two.

what were the … two parts for how [wiggling two fingers of left hand]?

Augusto: Pressure and

Linda: No no no … What did the book just say [pointing to the book]?

Augusto: I don’t know …

Linda: We’re not talking about metamorphic [pointing the Metamorphic
28 column], we’re talking about igneous [pointing to the Igneous column]
29 Augusto: Oh yeah. Magma
30 Linda: What does magma do?
31 Augusto: Solidification
32 Linda: Solidification [writing “solidification” on the board next to the
33 word “how”] … And what was the other one? What happens to this
34 magma [pointing to the word “magma” under the Igenous column on the white board]?
35 Augusto: (inaudible)
36 Linda: Over time it [raising both hands up in front of her and slowly bringing them
down]
37 Augusto: Erupts
38 Linda: No [repeating the raising and lowering of her hands]
39 Students: (inaudible) like …
40 Linda: Cools
41 Augusto: Cool down (inaudible) …
42 Linda: La temperatura ir abajo …Recuerdan (The temperature goes
down … Remember)? Remember that word we talked about was
44 ‘cooling’ [writing “cooling of magma” on the white board under “solidification” and
then bracketing those next to the word “how”]
45 Students: Cooling (laughter)
46 Students: Dice que lo va a poner otra vez (He says he’ll put it again)
47 Linda: OK, we've answered the … how … and we've answered the
48 where [holding up left hand and hitting two fingers with the dry erase pen]

Significantly, Augusto exerts a control strategy in this sequence by posing a student challenge to Linda, indicating that they haven’t learned how igneous rocks form (“But I wanna know HOW”—line 19). Linda responds by indicating that his challenge was irrelevant (“Didn’t we already answer how?”—line 20), though she does eventually concede to responding to Augusto’s request, referring to the information in the text she just read as old information (“What were the two parts for how?”—lines 22–23, our emphasis). The answer she provides to the question “How do igneous rocks form” consists of two vocabulary words: “solidification” (lines 31–32) and “cooling” (line 44). Notably, what these processes involve is not explained.

In this excerpt we see Linda reduce the process of rock formation to two lexical information bits, what Linda referred to as the “two parts of how”: solidification and cooling. Augusto easily supplies solidification, the first vocabulary word they have been taught to associate with “magma” in line 31, but has more trouble with cooling which Linda tries to cue through pantomime (lines 36–38). Students use word-level responses for information that would otherwise require sentence-level responses. When Linda asks “What does magma do? (line 30),” Augusto replies with “solidification” (line 31), a discursively inappropriate follow-up to Linda would be at the syntactical level, i.e., “It solidifies.” But Linda accepted his response and wrote it on the board. She then asked about the other lexicalized information bit—”What was the other one? What happens to this magma? (lines 33–34) and “Remember that word we talked about was cooling? (lines 43–44),” Her framing of the desired response as “the other one,” “that word we talked about,” illustrates how she has reduced the process of rock formation to lexical items only. In fact, Linda’s question “remember that word we talked
“about?” acts as a signal of explicit academic language instruction, a marker that the discourse has turned away from the science content, how igneous rocks form, and towards the nature of the discourse itself, in this case the word “cooling.”\(^5\) It is this word, which she adds to the board, and its partner, “solidification,” that Linda wants the students to associate with the process of igneous rock formation. Just as, by lesson’s end, she will, continuing in this manner, teach the students to associate the words “extrusive” and “volcanic” with “lava” and “intrusive” and “plutonic” with “magma.” This is exemplified by the contents of the white board at the end of this sequence, as depicted in Fig. 4.

Both the verbal and visual data attest to the lexicalization of Linda’s rock cycle lesson. By its very nature, this lexicalization overshadows the semantic relations that bind together the conceptual content of the lesson. In so doing, it ignores and thus fails to not only model, but also simply provide for the students the linguistically construed meaning necessary to fully realize and articulate those relations.

Linda’s belief, as she explained to us in her interview, that academic language instruction means teaching vocabulary, constrains the linguistic and conceptual input she provides students. Going further, it also restricts student opportunities for linguistic and conceptual output as well. In the final Application/Review phase of the rock cycle lesson, she asks the students in a seatwork activity to, “using the information from the board,” create a t-chart in which they “write down as much as [they] can” about extrusive and intrusive rocks. On the back, she asks them to draw a picture that summarizes their t-chart information, even providing them with red crayons so they can “show [her] how hot the magma is.” Importantly, she tells them that they will be using this assignment to study for the test.

\(^5\)Rittenhouse (1998), in her discussion of mathematical conversation, refers to the teacher’s turning towards the discourse (form) and away from the content (meaning), as “stepping in and stepping out.”
When Juan expresses interest in writing in Spanish about what he knows, she insists that Juan must explain himself in a drawing:

Linda: [approaching Juan’s small group and seemingly commenting on a drawing Juan has made of a volcano] OK. Why is volcano important? Por qué está importante (why is it important) in the rock cycle?
Juan: Porque de ahí salen las rocas igneas, de ahí salen todas las rocas (Because igneous rocks come from there)
Linda: [pointing to his picture] … Dime con dibujo (Show me with a picture)
Juan: (inaudible, apparently revoicing his interest in writing about the information in Spanish)
Linda: I don’t know Spanish [holding her hand on her chest and shaking her head, then rolling her eyes and sticking out her tongue to indicate the “silliness” of what she is saying because, indeed, she uses Spanish routinely to communicate to this class] … I need to know it in your picture

Linda’s final assignment for the rock cycle lesson, then, was to have the students produce a list of the words and phrases taught in the lesson and accompany that with an illustration. What is noteworthy is that, again, she does not encourage students to produce extended discourse nor does she ask them to indicate their understanding of the semantic relationships that bind these words together into a coherent scientific accounting of rock formation processes. To do so would require the use of conceptual and linguistic resources at the syntactical level and Linda has not modeled or taught these. When one of her students expresses interest and willingness to write in Spanish to display what he learned from the lesson, Linda insists that he “show [her] with a picture.” So, while she had stated to us in her interview that, in her classroom, content comes first, her decision to disallow this student’s request indicates that, in fact, she’s more interested in assessing the lesson as an illustrated vocabulary lesson than as a science lesson. To underscore this point, her face making when she falsely states that she does not know Spanish speaks to the air of artifice that characterizes her science instruction. In that moment, her masquerading as a non-Spanish speaker is akin to the way in which this approach to teaching ELs masquerades as science instruction.

Mohan (2006) illustrates in his comparison of a mainstream science and an ESL science setting the learning disparities that can result when the teaching of technical terms, in the ESL science setting, is isolated from a scientific explanation of the processes to which they refer. In our study, we also see how a vocabulary-focused understanding of academic language instruction has trumped the science goals in this classroom.

6.2. The discourse economy of “EL science”

As a sociocultural, semiotic theory of language proposes, the relationship between language (form) and content (meaning) is symbiotic. Grammatical structures don’t just get used in contexts, they realize the particular contexts in which they are used. Thus, Linda’s emphasis on vocabulary teaching constructs as much as it represents an important element of the social action, of what is taking place in, the “EL Science” classroom. The use of nominalization, for example, while serving, linguistically, to “compact information” (Halliday & Martin, 1993) also serves to “compact” the content of what is taught and learned in that setting. As it does so, it necessarily and simultaneously structures the interpersonal dynamic of the classroom, imbuing a particular tone to the interaction, for
instance, between Linda and Augusto that reflects and constructs the role structure of the EL Science setting. This necessarily and simultaneously construes the “text” of the science instruction that unfolds in this classroom, achieving the organization and function of communication, the discourse economy, we observed therein.6

Any examination of attempts to integrate language teaching into content teaching must take the view that “language [is] a social process that contributes to the realization of different social contexts” (Schleppegrell, 2004, p. 45, drawing on Halliday & Hasan, 1989; Halliday, 1985). It must consider how the integration of processes related to explicit language instruction achieves a particular science-teaching-and-learning context. For our purposes, that particularity is captured by the idea of a didactic tension between the goals of developing language and developing content. The actions of teachers, who, like Linda, understand academic language instruction as vocabulary instruction may function to create a situational context in which the register of science is altogether different than it is in other classroom contexts that do not have academic language instruction as a major goal (i.e., classrooms without EL students). Because ELs are assessed, however, not according to the register of “EL Science” but by the register of mainstream science, this poses a significant obstacle to the goal of educational equity for language minority students in US schools.

If science teachers have limited understandings of the relationship between content and language, attempts at explicit instruction may stress the didactic tension. Teachers may explicitly teach language forms, vocabulary, for example, that, in fact, only partially or superficially align with the semantic relationships that exist among the natural phenomena that are at the heart of lesson content; they may not provide sufficient input and output opportunities featuring the particular grammatical structures needed to express the taxonomic relationships, for instance, so central to science. Thus, while teachers may believe in the goals of integrating science and language instruction, in the way they put those beliefs into practice, they may be emphasizing some aspects of academic language only to continue to obscure others. They may, in effect, not adequately or accurately capture “the language of the content.” In “watering down” (Martin, 1993) the linguistic technology, they may also be “watering down” the content of science.

We know that, in general, teachers’ understandings of academic language are limited, revolving principally, as researchers have remarked, around the idea of vocabulary (O’Toole, 1996; Solomon & Rhodes, 1995). We also know that these vocabulary-based conceptions of academic language ignore other important linguistic features, such as the unique grammatical and discursive patterns that comprise the genres (recounts, narratives, reports, expository essays, etc.) of a content area (Colombi & Schleppegrell, 2002; Schleppegrell, 2001, 2004). In this way, we can further know that the goal of integrating explicit academic language instruction into science will be insufficient without attending in a comprehensive way to the complex configuration of linguistic features that structure the kinds of written and oral texts expected at school. Vocabulary-based approaches to academic language instruction, therefore, albeit against best intentions, are likely to continue to withhold from EL students the very linguistic input and output they need in order to acquire the language of science. In narrowing the range of attention that teachers of ELs place on the linguistic demands of science, vocabulary-based approaches may also substantively compromise cognitive development. They may reduce instructional expecta-

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6For more information on the relationship between contextual variables and their linguistic realization see Halliday’s (1985), (Halliday & Hasan, 1989) discussion of field, tenor, and mode.
tions, demands, and performance, as well as students’ opportunities to demonstrate achievement and meet identified academic criteria.

7. Conclusion

Taking the call for integrated instruction seriously means taking what is known about quality science education and infusing into those goals of cognitive development corollary goals of language development. Just as science education is about meaningful inquiry into real-world problems and the opportunity to apply and generate conceptual knowledge in collaboration with students, teachers, and other members of the scientific community (Goldman, 1997; Krajcik, Blumenfeld, Marx, Bass, & Fredricks, 1998; Mercado, 1992; Merino & Hammond, 1998), it is also about the language and literacy upon which such activities of inquiry, application, generation, and collaboration rely.

So what’s language got to do with it? Linda’s case helps us see more concretely how language choices shape what kind of science learning takes place. It helps us understand the kinds of semantic relations upon which conceptual development in science relies and how, while students may be exposed to these semantic relations as part of the implicit content of science instruction, they may not be explicitly provided with opportunities to use the linguistic resources that are needed to adequately express the science processes expressed through these semantic relations. It also helps us see the differences in opportunities for linguistic and conceptual development that may exist between native English speakers and their EL peers.

While this case cannot represent all EL science settings, it gives us a glimpse of the learning environments that may exist for science instruction with EL students and the role that language plays in creating those. It provides a cautionary example of what can happen to science teaching and learning when it is driven by a simplistic approach to academic language instruction. It helps us see that, in providing integrated instruction for EL students, striking a balance between teaching the content and language of science merits further attention and that, moreover, vocabulary-driven approaches are not the quick fix to EL science instruction that some educational scholars (Echevarria, Vogt, & Short, 2004) may want them to be. Linda’s case lends support to the claim that simplified understandings of explicit academic language instruction, in leading to simplified science talk, result in simplified science (Mohan, 2006).

Different language practices are associated with differentiation of learning in US school “tracks” (Harklau, 1994; Medina, 1988; Mehan, Hubbard, & Villanueva, 1994; Oakes, Gamoran, & Page, 1992). From our review of Linda’s case, we are concerned that explicit, vocabulary-focused academic language instruction may carry its own hidden curriculum; it may continue to deprive EL students of the input and output opportunities they need to develop full proficiency in the language of science and, moreover, its habits of mind. In effect, the discourse economy generated through explicit academic language instruction thus conceived, may, contrary to its stated purposes, help “achieve school failure” (McDermott, 1997) for EL youth in US schools.

References


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