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Engaging Students in Guided Science Inquiry Discussions: Elementary Teachers' Oral Strategies

Alandeom W. Oliveira

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Abstract This study explores how elementary teachers perceive and use *engaging oral strategies* (i.e., manners of speaking that encourage students to participate and become engaged in science discussions). It is reported that the strategies employed as well as their frequency varied substantially depending upon on the teachers' grade level and perceptions. While a kindergarten teacher viewed such strategies negatively and employed only a few figurative directives, fourth-grade teachers viewed them positively, frequently resorting to a variety of speech figures, parallel repetition and engaging questions. It is argued that teachers' engaging oral strategies are multifunctional, serving important social and cognitive functions.

Keywords Student engagement · Inquiry · Science discussion · Elementary teacher · Speech figure · Poetics

Elementary educators have adopted a wide variety of strategies to foster student engagement in science discussions. Some have successfully used puppets as a resource to stimulate children engagement and participation in oral argumentation and reasoning, enhance students' interest and motivation to learn science concepts, and introduce pupils to alternative perspectives or views on scientific issues in a non-threatening manner (Low and Matthew 2000; Simon et al. 2008). Others have resorted to conceptual cartoons—teacher-generated visual artifacts wherein three or four characters engage in a short, non-humorous dialogue and express incompatible views or opinions on everyday scientific phenomena—to effectively initiate engaging and non-threatening discussions wherein students feel encouraged to share prior

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understandings, give opinions, defend positions, and critically and respectfully analyze alternative points of views (Cleveland and Fox 2008; Keogh and Naylor 1999). Some teachers have also sought to foster student engagement and interest in science by means of content-related humor, using exaggerated comic movies such as *The Three Stooges* while facilitating discussions about physical principles (friction, gravity, momentum) and satirized cartoons when teaching about brain hemisphericity (Garret and Shade 2004; Shade 1996). In my own classroom, I have used a short segment of the fictional film AntZ—the scene where Princess Bala attempts to free the worker ant Z-4195 by hitting a water drop with a tiny twig but is unable to break through its seemingly solid surface—in the Engage phase of a 5-E learning cycle lesson (Marek 2008; Trowbridge et al. 2004) wherein students investigate several chemical properties of water, including surface tension, cohesion and adhesion.

One of the most common student-engaging strategies used by elementary science educators is children's literature. Many have adopted science read-aloud strategies (i.e., whole-class, aloud reading of children's science books) as an effective way of increasing primary students' achievement and motivation, and encourage students to develop a love for science (Kletzien and Dreher 2004; Lake 1993). Others have strategically resorted to children's books with high-quality illustrations and photography, and interesting and non-threatening texts that elementary students find appealing (Ford 2006; Lapp and Flood 1995). And, many elementary and middle school teachers have used children's literature to draw young students into scientific topics as varied as the moon (Trundle et al. 2008), earth and space (Peacock and Weedon 2002), magnetism (Barrow and Robinson 2007), the environment (Oliveira et al. 2009), states of matter (Pappas et al. 2003), life cycles (Donovan and Smolkin 2001) and even Einstein's theory of relativity (Stannard 1999).

Less well known, researched and deliberately used are elementary teachers' *engaging oral strategies* (i.e., manners of speaking or addressing students that can generate engaged science talk in elementary classrooms). Most of the scant research currently available has been conducted at higher grade levels, leaving elementary teachers' engaging oral strategies as well as their perceptions of these linguistic practices largely unexplored. This research is reviewed below.

Research Questions

This study is framed by the following two research questions:

1. What oral strategies do elementary teachers adopt to promote student engagement in guided science inquiry discussions?
2. How do elementary teachers' perceive engaging oral strategies?

Theoretical Framework

The present study adopts a sociocultural perspective on classroom discourse, emphasizing that the spoken language that elementary teachers employ while

facilitating guided science inquiry discussions serves both cognitive and social functions (Oliveira et al. 2007). From this multifunctional theoretical perspective, when teachers talk about science, not only do they inform students and scaffold their scientific thinking but they also interact socially with students, keeping them engaged in the discussions and motivated to learn science concepts. In other words, teacher facilitation of guided science inquiry discussions entails not only the advancement of student cognition but also the social promotion of student engagement through oral language. In this study, the term "engagement" is used in reference to elementary teachers' oral language or manners of talk that are more focused on fostering student attentiveness and interest than on detached transmission of science content and information.

Engaging Students Orally

Previous analyses of classroom discourse have revealed that effective teachers resort to a variety of oral strategies to promote student engagement in science discussions. Lemke (1990) describes how secondary students tend to be more engaged and attentive to classroom science discussions when their chemistry teachers use figures of speech such as metaphors (e.g., electrons coming to town, looking for the cheapest hotel, and then going to the orbital of lowest energy) and personifications (e.g., "*the orbital is fat and skinny*" and "*they* [electrons] *like to have opposite spins*"), colloquial language, and humorous comments such as "*relativity, that's how Einstein made his fortune*" and "*all of you who watch Star Trek and Planet of the Lost Chickens, and all of those terrific programs must know what that* [the word terrestrial] *means*." Similarly, Nunn (1996) points out that humorous comments and rhetorical questions—oral queries posed without an expectation for actual student responses—are among the most frequent oral strategies used by university faculty members to encourage student participation and engagement in whole-class discussions.

Other studies describe how some teachers resort to parallel repetition—repetition of same or similar linguistic patterns in adjacent sentences, clauses or utterances—to foster student engagement in classroom science discussions. Oliveira et al. (2009) point out that a fourth-grade teacher, after highlighting many different ways by which humans cause river pollution, utters "*Is there a guilty animal? Any ant? Any cow? Any sheep? Any lion?*" This teacher follows his initial question with four parallel repetitions of the structure [any] + [noun] while creating a list of possibly "guilty" animals. Similarly, Oliveira et al. (2007) describe how, while investigating how wax candles work, a college student requests her professor's assistance by uttering "*we've got a couple of questions*" to which the professor immediately replies "*And I have lots of answers*." Both the student and professor utterances followed the same structural pattern: [personal pronoun] + [possessive verb] + [quantifier] + [noun]. In this case, the professor seeks to foster student engagement by attempting to be amusing through strategic repetition of the same structural pattern used by the student. Because such repetitive patterns of language use are relatively unusual in oral discourse (being more commonly found in written poetry),

they sound amusing and draw students' attention to classroom discussions, thus leading to higher levels of engagement.

The above studies show that effective teachers speak in ways that encourage their students to participate and become engaged in classroom discussions. These teachers frequently resort to a variety of engaging oral strategies such as parallel repetition, figures of speech, colloquial language, humorous comments and rhetorical questions. In this study, I explore how elementary teachers perceive and use these oral strategies to promote student participation and engagement in guided science inquiry discussions.

Methodology

The present study adopted a mixed-method research approach (Bogdan and Biklen 2003; Creswell 2003) wherein descriptive data were systematically collected through open-ended research methods (video-recorded classroom observation and semi-structured interviews) and then analyzed qualitatively and quantitatively to build a naturalistic account (Lincoln and Guba 1985) of elementary teachers' classroom employment and perception of engaging oral strategies in the context of guided science inquiry discussions. The reported findings constitute a naturalistic account because they focus on oral engaging strategies that teachers "naturally" adopt in their classrooms, that is, without the researcher's interference.

The participants were three elementary teachers who were assigned the following pseudonyms: Mrs. Nichols (kindergarten), Mrs. Parker (fourth grade) and Mrs. Smith (fourth grade). These teachers were video-recorded while facilitating six science inquiry discussions in their classrooms (two discussions per teacher). These discussions were part of lessons based on several FOSS modules for elementary grades (Lawrence Hall of Science 2005) and constituted "guided scientific inquiry" (Furtak 2006), a more structured variation of science inquiry teaching wherein students were provided with research questions and then guided through investigations whose answers were known by their teachers. Although the lessons were not "open inquiry" (NRC 1996), they were consistent with the essential features of classroom inquiry: students were engaged by scientifically oriented questions, used evidence to formulate explanations, evaluated explanations in light of scientific understandings, and communicated and justified their explanations (NRC 2000, p. 25). Table 1 provides a description of the six guided science inquiry discussions.

The video-recordings were captured with a digital camcorder focused mainly on the teachers who wore a wireless lapel microphone while facilitating guided science inquiry discussions. In recruiting participants for the present study, I sought to include teachers with a range of science teaching experiences (low, intermediary and high) and grade levels (both K-3 and 4–6). Mrs. Nichols was the least experienced participant with only 4 years of science teaching experience, whereas Mrs. Parker and Mrs. Smith were considerably more experienced in teaching science (8 and 25 years, respectively). All teachers taught science on weekly basis in suburban elementary schools that served a predominantly white, upper middle-class student population in the Midwest.

Table 1 Video-recorded guided science inquiry discussions

Teacher	Lesson 1	Lesson 2
Nichols	*Chicken eggs and embryos*[a]: whole-class discussion about a chart with pictures of the developmental stages of a chick, and observations of incubated eggs held against the light of a slide projector.	*The physical properties and uses of fabrics*[a]: whole-class discussion about fabric, common objects made of fabric, and observations of fabric samples (e.g., burlap, corduroy, denim, fleece, knit, nylon, etc).
Parker	*The strength of electromagnets*[b]: whole-class discussion about inquiry and relationship between number of winds of wire around a rivet and number of washers picked up.	*Crayfish*[b]: whole-class discussion about scientific inquiry, Rocky the singing lobster (an electronic model that dances, shakes its claws and tail), and crawfish behaviors.
Smith	*The motion of rolling spheres*[b]: whole-class discussion about motion, force and gravity, and construction of rollercoaster models.	*Constructing cart models*[b]: whole-class discussion about engineers' use of models and construction of self-propelled carts.

[a] 15-min lessons

[b] 50-min lessons

Mrs. Nichols, Parker and Smith obtained their elementary teaching certificates from the same institution of higher of education where they were required to take 12 credits of undergraduate science content courses (one physics, one biology, one chemistry and one earth science) plus a science teaching methods course. They also participated in a 3-year professional development program called "Scientific Modeling for Inquiring Teachers Network (SMIT'N)" that prepared them to incorporate scientific modeling within a 5-E learning cycle approach, scientific inquiry and nature of science into their classroom practices.

Data collection methods included video-recording of teachers' facilitation of guided science inquiry discussions followed by individual, semi-structured interviews. Teachers were interviewed at the end of their second classroom discussion. Both qualitative and quantitative methods of data analysis were used to examine the nature and frequency of elementary teachers' engaging oral strategies as well as their perceptions of these discursive practices.

Question 1: Teachers' Engaging Oral Strategies

To examine how elementary teachers orally promoted student engagement and participation in guided science inquiry discussions, I conducted a content analysis of transcribed recordings of the six science lessons. This analysis was guided by an observational coding system developed based on a review of the scholarly literature on teachers' engaging oral strategies (see previous section). The coding system comprised three distinct categories of engaging oral strategies described in the literature: (1) figurative language; (2) parallel repetition; and, (3) engaging questions. The unit of analysis was teachers' utterances which were defined as individual units of naturally occurring speech bound by silence or speaker turn taking.

Each code was operationally defined as follows. *Figurative language* (code 1) was defined as words, phrases and expressions that teachers used in non-literal ways (not according to common or dictionary usage) and that required students to draw on

shared background, cultural knowledge and/or imagination in order to interpret teachers' intended meaning. Included in this definition were commonly used figures of speech such as metonymy, synecdoche, irony, exaggeration, and personification. See Table 2 for definitions and examples. *Parallel repetition* (code 2) was defined as repetitions of sounds, words, and grammatical structures that deviated from ordinary patterns of word usage commonly encountered in classroom oral discourse. Included in this definition were alliterations, reduplications, triplets, onomatopoeia, word repetitions, and structural repetitions (see Table 3 for definitions and examples). Finally, *engaging questions* (code 3) was defined as oral queries more focused on student engagement than on student cognition. These engaging questions served to draw students' attention and encourage their participation rather than elicit information yet to be discussed or further students' understandings and thinking about particular science concepts. Included in this definition were rhetorical questions and humorous questions. Rhetorical questions were posed by teachers without an expectation for actual student responses (they were either answered immediately by the teacher herself or remained unanswered). In contrast, humorous questions promoted student amusement and laughter as well as short affirmative or negative responses but did not elicit any new information, justification or elaboration.

Question 2: Teachers' Perceptions of Engaging Oral Strategies

After facilitating the second guided science inquiry discussion, each teacher participated in a semi-structured interview that lasted about 30 min. This interview was open-ended and followed a flexible protocol, that is, the interviewer was free to modify the sequence and wording of questions, omit or add questions, and determine the amount of time and attention given to each question (Bernard 2002). During the interviews, teachers were first asked to comment on engaging oral strategies described in the scholarly literature, including figures of speech and parallel repetition (also referred to as poetic language). More specifically, teachers were provided with several examples drawn from the scholarly studies reviewed above and then asked to comment on the value, effectiveness and potential implications and complications of using such oral practices in elementary classrooms. After that, teachers were asked whether they sought to promote student engagement orally in their own classrooms, and describe and illustrate engaging oral strategies they commonly adopted both prior to and during their facilitation of the two guided science inquiry discussions.

Findings

The findings presented in this section are organized by the two research questions. First, attention is given to teachers' engaging oral strategies (Question 1). Next, the focus shifts to teachers' perceptions of these engaging oral strategies (Question 2). In all transcript excerpts and quotations, underlining is used to identify key linguistic features and [ ] to indicate researcher comments.

Table 2 Figures of speech used by elementary teachers

Speech figure	Definition	Teacher	Frequency	Examples
Metonymy	Word substitution wherein an object, being or idea is referred to not by its actual name but by the naming of something near or closely related.	Nichols	2	"*Travis you need to be on your pockets*" instead of "*Travis, sit down*" (Lesson 2)
		Parker	2	"*Today, I want you to look at it with different eyes, okay?*" (Lesson 2) "*Inquiring minds want to know*" (Lesson 2)
				"*If you group's* [electromagnet] *is not working, would you fishbowl*?" (Lesson 1)
		Smith	4	"*Freeze everyone, voices freeze at the same time*" (Lesson 2)
Synecdoche	A form of metonymy in which a part of an object, being or idea is used to refer to its whole.	Nichols	5	"*Kindergarten, can I have your eyes and ears?*" instead of "*can you pay attention?*" (Lesson 2)
				"*Can you keep your hands to your self?*" (Lesson 1)
		Parker	11	"*After you collected your data, eyes on me"* instead of "*pay attention*" (Lesson 1)
				"*Eyes up here*" (Lesson 1)
				"*I've got a few more hands*" (Lesson 1)
				"*Are you curious as to whether crayfish have a sweet tooth or not*?" (Lesson 2)
				"*Hands up only speaking*" (Lesson 2)
Irony	The use of a word or expression in a way that conveys the opposite of its literal meaning.	Smith	1	"*Ok, these are your instructions, your roller coaster must have a name, that's gonna be extremely difficult for you*" (Lesson 1)
Exaggeration	The deliberate overstatement of an idea to create emphasis, strong feelings or strong impressions.	Parker	2	"*Twenty five* [washers]*, I heard. Are these logical answers? Would it make sense to say ten thousand* [washers]*?*" (Lesson 1)
				"*Olivia is completely going to burst if I don't let her speak*" (Lesson 2)
		Smith	1	"*Don't let me put your eye out* [with the marble]… *it could be a lawsuit*" (Lesson 1)

Table 2 continued

Speech figure	Definition	Teacher	Frequency	Examples
Personification	Attribution of human qualities to inanimate objects, animals or natural phenomena.	Parker	12	"*The bell will be calling for buses*" (Lesson 1)
				"*The x-axis at the bottom wants to know the number of winds*" (Lesson 1)
				"*It [crayfish] is not inviting us to sing or dance, is it*?" (Lesson 2)
				"*The ones* [crayfish] *that molted had little jackets*" (Lesson 2)
				"*Why do you think it* [crayfish] *is a girl*?" (Lesson 2)
				"*The crayfish is mean, or the crayfish hates us, or loves us*" (Lesson 2)
		Smith	3	"*The gravel tries to, it has a mind of its own, and it reaches up and grabs the spokes of your bicycle, and stops you*" (Lesson 1)
				"*I'm holding it away from the gravity that wants to take it*" (Lesson 1)
				"*Kunta* [class turtle] *wants to be on camera*" (Lesson 1)

Question 1: Teachers' Engaging Oral Strategies

Elementary teachers' oral strategies were grouped into three different categories, namely figurative language, parallel repetition and engaging questions. Each category is described and illustrated next.

Figurative Language

Combined, the three teachers uttered 16 synecdoches, 15 personifications, 8 metonymies, 3 exaggerations and 1 irony while facilitating guided science inquiry discussions. Metonymy was the only speech figure consistently utilized by elementary teachers across all guided science inquiry discussions. In contrast, teachers' employment of other figures varied (see Table 2).

All three teachers employed synecdoches and/or metonymies while giving whole-class directives to their students (e.g., "*can I have your eyes and ears?*" "*freeze everyone*" and "*eyes on me*"). These figurative directives were usually directed at student misbehavior (e.g., side-talking) and served to avoid sounding excessively authoritative, save students' face (Goffman 1967) or sense of personal dignity, and foster student engagement through strategic employment of colorful

Table 3 Common forms of parallel repetition

Repetition form	Definition	Teacher	Frequency	Example
Alliteration	Repeating word-initial sounds in the same phrase.	Nichols	1	"*It* [the fabric] *could be a very nice shimmery, shiny skirt, couldn't it*?" (Lesson 2)
		Parker	1	"*So are we in agreement then that we saw the behaviors of tail flapping, flopping [starts writing on transparency] flapping, flipping, and you called it flailing*" (Lesson 2)
				"*The variable that investigators change is called the independent variable*" (Lesson 1)
Reduplications	Repetition of the root, stem or part of a word.	Smith	1	"*The loopy loop* [in the roller coaster]?" (Lesson 1)
Triplet	Placing 3 terms side by side to encourage listeners to consider what they have in common.	Smith	1	"*Ok, who here has ever, in the winter, we talked about gravel, winter, ice, bicycle*" instead of "*who has ever ridden a bicycle in the winter*?" (Lesson 1)
Onomatopoeia	Word repetitions that imitate the sound(s) being described.	Parker	1	"*It [crayfish specimen] was just standing there and it would go huh, huh, huh, huh, huh*" [enacting observed crawfish behavior] (Lesson 2)
		Smith	2	"*So what is shhhh* [friction]*? What's the word for shhhhing?*" (Lesson 1)
Word repetitions	Repetitions of the same word(s) in adjacent sentences, clauses or utterances.	Parker	4	"*Raise your hands. Uh, I like the hands, the hands, hands, hands, think about it*" (Lesson 1)
				"*An interrogative sentence inquires. An interrogative sentence inquires [she smiles] I will say it again, an interrogative sentence inquires. What do interrogative sentences do? What's the job of those sentences?*" (Lesson 2)
Structural repetitions	Repetitions of the same linguistic structure in adjacent sentences, clauses or utterances.	Parker	2	"*If Bob is winding this way, over the top, over the top, over the top* [moving one hand clockwise around the other]*, he does it the first time over the top, then the second time he does it under the back, under the back* [moving hand counterclockwise]*, is that a logical experiment?*" (Lesson 1)
				"*I want you to set everything aside on your desk, we're just using our brains today in order to use our hands later in the week, okay?*" (Lesson 2)

Table 3 continued

Repetition form	Definition	Teacher	Frequency	Example
		Smith	1	"*So again, what is peddling doing? We talked that it's turning the gear that turns the chain that turns the axle that turns the wheel and hence you go forward.*" (Lesson 2)

linguistic forms in place of more potentially face-threatening commands such as "*pay attention*" and "*shut up*."

Mrs. Parker was the only teacher to utilize an exaggeration to promote conceptual understanding. While encouraging her students to recognize that the magnetic force of an electromagnet was directly proportional to the number of winds of wire around its core, Mrs. Parker asked pupils to predict how many washers could be picked up with twenty winds of wire. In response, students provided numbers such as ten, fifteen, and twenty five washers. Mrs. Parker then uttered an exaggeration ("*would it make sense to say ten thousand?*") to communicate to students that predictions are not random guesses, but reasonable numbers based upon one's previous experiences.

While eliciting her students' prior experiences and conceptions of force, Mrs. Smith employed two personifications ("*the gravel reaches up and grabs the spokes of your bicycle*," and "*the gravity wants to take it*"). Such linguistic forms did not serve an cognitive function, that is, Mrs. Smith does not use them to improve students' understandings related to the concepts of force and gravity. Instead, Mrs. Smith sought to foster student engagement in the whole-class discussion by strategically employing amusing or engaging speech.

Parallel Repetition

Together, the teachers employed 4 word repetitions, 3 structural repetitions, 3 onomatopoeias, 2 alliterations, 1 reduplication, and 1 triplet. Mrs. Nichols used parallel repletion the least (only 1 alliteration). In contrast, the two fourth-grade teachers resorted to multiple forms of parallel repetition (see Table 3).

Two elementary teachers resorted to alliteration. During a discussion about the utility of a particular glossy fabric sample, Mrs. Nichols reacted to her student's idea that their fabric sample could be used for making a skirt by uttering a series of words with "S" sounds: "*It* [the fabric] *could be a very nice shimmery, shiny skirt, couldn't it*?" Likewise, Mrs. Parker resorted to alliteration when she compared the performance of a singing lobster toy to real crayfish behavior "*So are we in agreement then that we saw the behaviors of tail flapping, flopping* [starts writing on transparency] *flapping, flipping, and you called it flailing*." These alliterations are interactionally multifunctional. Not only do they serve to promote student engagement through employment of amusing and unusual word patterns but they also constitute a mnemonic strategy aimed at helping students recall the information being discussed.

The form of parallel repetitions most commonly used by elementary teachers was word repetitions. At the beginning of the inquiry on electromagnets, Mrs. Parker uttered the following directive "*Raise your hands. Uhh, I like the hands, the hands, hands, hands, think about it.*" Mrs. Parker first uttered an imperative and then immediately followed it with a series of parallel repetitions of the word "hand." Her directive served multiple interactional functions. First, Mrs. Parker's parallel repetitions allowed her to avoid sounding excessively authoritarian while giving directives. Second, her repetitions of the word "hand" were also amusing, a strategy aimed at fostering student engagement. And, third, Mrs. Parker's parallel repetitions also served to slow down her students and encourage them to reflect carefully about her question before attempting to get a hold of the discussion floor, thus serving a classroom management function.

Structural repetition was utilized only by the two fourth-grade teachers. During the electromagnet discussion, Mrs. Parker made use of structural repetitions to emphasize to students that the direction in which they wound the electric wire was an important variable to control when constructing an electromagnet: "*the direction that you wind it* [the wire]… *if Bob is winding this way, over the top, over the top, over the top*" [moving one hand clockwise around the other], *he does it the first time over the top, then the second time he does it under the back, under the back* [moving hand counterclockwise], *is that a logical experiment? Is that consistent? No.* Rather than telling students directly that the wire needed to be wound in the same direction every time, Mrs. Parker resorted to structural repetition ("*over the top/under the back*"), fostering student engagement in the discussion while enacting what she considered to be an inconsistent investigative approach. Similarly, while discussing the mechanism whereby riders are able to make the wheels of their bicycles rotate, Mrs. Smith uttered "*so again, what is peddling doing? We talked that it's turning the gear that turns the chain that turns the axle that turns the wheel and hence you go forward.*" Mrs. Smith not only fostered engagement but also provided a richly detailed description that students were likely to recall.

Mrs. Smith was the only teacher to employ a triplet. While eliciting her students' prior experiences and conceptions of force, she uttered "*ok, who here has ever, in the winter, we talked about gravel, winter, ice, bicycle* [all students raise their hands]." Instead of finishing the question she started to pose ("*who has ever ridden a bicycle in the winter*?"), Mrs. Smith aborted and then replaced it with a triplet ("*winter, ice, bicycle*"). In doing so, Mrs. Smith sought to foster engagement among her students who did not seem to be confused by her unusual form of speaking.

Engaging Questions. Mrs. Parker attempted to promote student engagement in science discussions by posing 9 rhetorical questions. For instance, while using the behavioral issue raised by her student Diego ("*why crayfish would eat French fries but they wouldn't take cat food?*") as an example to articulate what she considered to be the attributes of a good research question, Mrs. Parker made the following comments "*his question is an excellent one for three reasons, first of all, it's something he really is curious about. Do you wanna answer a question that you think is boring? I don't care why they do this* [enacting boredom] *would you even wanna do research on that? No."* Soon after that, Mrs. Parker also uttered "*Don't you hate it when you're asked to figure something out when you know the answer*

already? I already have the answer to that." Rather than actual requests aimed at eliciting information from the students, Mrs. Parker asked rhetorical questions, that is, queries aimed at arousing her students' interest and engagement in the discussion.

Mrs. Smith posed 7 humorous questions whose primary function was to foster student engagement in the discussion rather than to further students' understandings of scientific models. Such strategy was adopted by Mrs. Smith when she asked her students to describe how her student Roger could possibly approach the hypothetical task of designing the interior of a new state building for Indiana: "*Would he* [Roger] *go over there* [to the old building] *with a big chainsaw?*" and "*Would he* [Roger] *go and make a full state building, and say hey guys, do you want it?* Similarly, when the topic under discussion was wheels and cars, Mrs. Smith asked the following questions: "*If I asked you to make a go-cart, and told you that you have 30 min to do it, do you think you would be making one that you could sit in?*", "*Do you peddle your car?*" and "*Would you like to peddle a car?*" In all instances, students reacted to Mrs. Smith's yes-or-no questions with laughter, providing negative responses without any justification, elaboration or added information. Instead of eliciting new information from students, such convergent and arguably obvious queries served to foster student engagement in the discussion by means of humor or amusement.

Question 2: Teachers' Perceptions of Engaging Oral Strategies

The three elementary teachers perceived engaging oral strategies differently. Presented below are each individual teacher's perceptions of engaging oral strategies.

Mrs. Nichols

While reacting to scholarly descriptions of engaging oral strategies, the kindergarten teacher expressed her concerns and negative views of the use of poetic language (speech figures and parallel repetition) by elementary teachers, depicting it as a verbal practice that can be potentially confusing and unintelligible to students in lower grade levels. In her own words, "I feel that a teacher must be extremely careful of word choice and not use a lot of metonymy, which are often taken too literally by primary aged students. Poetic talk does not really belong in a kindergarten classroom." Furthermore, when asked about her employment of oral engaging strategies during science discussions, she replied "I did not use any metonymy with such young students." Mrs. Nichols' negative perception explains the very low frequency of her engaging oral strategies (4 instances/discussion) which for the most part took the form of figurative directives, thus being primarily focused on classroom management (as opposed to science concepts).

Mrs. Parker

This fourth-grade teacher expressed a different perception of the poetic language described in scholarly literature: "I think that poetic language is very important

because it can really pull them [students] in and get them engaged… it keeps your lesson from being dull and uninteresting. Poetic language also encourages students to think about the meanings of words and the purposes they serve." As can be seen, Mrs. Parker held a more positive view of the use of poetic language in elementary classrooms, emphasizing its beneficial effects such as maintaining student interest (social function) and enhancing student understanding of particular words (cognitive function).

While commenting on her own employment of engaging oral strategies, Mrs. Parker described a previous lesson in which "[we] did the water cycle dance or water cycle song… they [students] all remembered that because it was like exciting and it was the language thing… umm, songs, rhymes, poems and things like that helped them remember, it was almost a mnemonic clue to remember something that they learned." Drawing on her previous teaching experiences, Mrs. Parker provides an example of a particular event that took place in her own classroom wherein she observed that poetic language indeed enhanced her students' ability to recall information presented during a science lesson on the water cycle.

Mrs. Parker explained her extensive use of engaging oral strategies (18 instances/discussion) for both conceptual understanding and classroom management in terms of her theater background "I'm very theatrical so I tend to act things sometimes in a silly way, I mean, I did a lot of theater in high school so a lot of the [engaging oral] strategies that I pull during the day come from my theater skills…sometimes I wonder if that totally throws them [students] off because their expectation is that the teacher is an authority figure." As can be seen, Mrs. Parker begins to wonder about the social implications of her frequent employment of poetic language, a discursive practice which she perceives as being potentially incongruent with some students' expectation for an authoritative teacher role.

Mrs. Smith

This fourth-grade teacher also viewed scholarly descriptions of engaging oral strategies in a positive manner: "I feel this type of language [poetic] used in classroom discourse is crucial to the atmosphere and resultant relationships established between student and teacher. Being able to create that type of communication in their learning environment helps them retain the information they will be able to recall decades from now." As can be seen, Mrs. Smith perceives poetic language as important to the establishment of a positive teacher-student relationship (a social function) and enhancing student recall of scientific information (a cognitive function). Despite her positive and multifunctional perception, Mrs. Smith's engaging oral strategies were relatively infrequent (about 6 cases/discussion) and for the most part focused on particular science concepts (rather than classroom management).

Mrs. Smith associated each of her engaging oral strategies to very specific social and cognitive functions:

> "When I teach, often I am exaggerating something or understating its significance. This is seen in the 'put out the eye leading to a lawsuit'

statement. I tend to use these to establish connections with students and apparently attempting to be cool."

"I will often use personification as a means to get points across to students. For instance, the ability for a marble to be trained, the gravel trying to reach up and grab your spokes. These are all ways in which I attempt to stretch the mind to create a metaphor between an inanimate object and relating its size or structure to something more active and mobile."

"My poetic language helps students create images of things that could happen or have happened involving my target concepts. [For instance] I wanted students to think of what might happen to the friction if they rode their bicycle on ice. However, instead of telling them to think of this particular event I simply and poetically said "Who has ever…winter, ice, bicycle?" Most of the students knew exactly where I was going with that and I was able to elicit a response involving friction."

As underlined above, Mrs. Smith recognizes that she often resorts to content-unrelated exaggerations to accomplish social goals such as connecting with students and projecting the image of a "cool" or friendly teacher. In contrast, she views both her personifications and parallel repetitions as serving cognitive functions. The former are aimed at encouraging her students to think metaphorically or analogically, whereas the latter are intended to advance students' conceptual understandings by evoking mental images of events or situations for their critical consideration.

Discussion

While facilitating guided science inquiry discussions, elementary teachers employed a wide variety of engaging oral strategies that served both social and cognitive functions. However, the strategies chosen as well as their frequency of employment varied substantially depending upon on the grade level taught and the teacher's perceptions of these strategies. In this section, I discuss these findings in light of empirical results and theoretical arguments found in the existing literature on teacher oral discourse. The discussion is framed by the two research questions.

Question 1: Teachers' Engaging Oral Strategies

The reported findings indicate that elementary teachers' employment of engaging oral strategies at higher grade-levels is more frequent and varied than that of primary teachers. While the kindergarten teacher's engaging oral strategies consisted of only a few directives with synecdoches and metonymies that served a classroom management function, the fourth-grade teachers frequently resorted to a much wider variety of speech figures (personification, irony, exaggeration, etc), different forms of parallel repetition (alliteration, triplet, reduplication, etc) and even engaging questions (rhetorical and humorous) that focused on both classroom management and science concepts.

This differential focus of teachers' engaging oral strategies on classroom management and science concept is significant and can be understood in terms of social and cognitive functions previously described in the scholarly literature. Some researchers have emphasized that figures of speech and parallel repetition serve important social functions such as enabling speakers to engage listeners emotionally and affectively, foster intimacy, and establish interpersonal relations that are less formal and socially distant (Swann and Maybin 2007); and, display and negotiate social identities such as "a fun person to be with" and "a member of the group" (Boxer and Cortes-Conde 1997). Others have underscored that these linguistic forms serve significant cognitive functions. Van Hook and Huziak-Clark (2008) describe how kindergarten teachers effectively use the cognitive hook "lift, squeeze, stretch and twist" (a quadruplet word repetition) to increase student recall of vocabulary needed to articulate how inanimate objects such as toys, springs and rubber bands can store elastic and gravitational forms of potential energy. Likewise, Glynn (2008; 2007) regards analogies (e.g., "a cell is like a Lego brick" and "a human eye is like a camera") as conceptual bridges that teachers use to further student understanding by connecting a familiar science concept to an unfamiliar one.

If, instead of viewing social and cognitive functions as being mutually exclusive, we adopt a multifunctional perspective, we come to the realization that Mrs. Nichols' engaging oral strategies served only social functions—to draw students' attention and project a non-authoritative image—that enabled her to manage her classroom effectively. In contrast, the two fourth-grade teachers' engaging oral strategies served both social and cognitive functions. Not only did their oral strategies enabled these teachers to manage their classrooms in a socially effective manner but they also provided them with a means to develop students' conceptual understandings by promoting recall of the scientific information being discussed, encouraging students to think metaphorically/analogically, conjuring up images of events or situations for critical consideration, and enhancing students' vocabulary comprehension.

Question 2: Teachers' Perceptions of Engaging Oral Strategies

Another important finding was that elementary teachers at different grade levels perceived engaging oral strategies differently. Mrs. Nichols perceived engaging oral strategies negatively and questioned their appropriateness on cognitive grounds, arguing that figures of speech such as metonymies can confuse younger students. In contrast, the two fourth-grade teachers viewed engaging oral strategies in a more positive manner, a stance that was justified on both social and cognitive grounds (establishing productive teacher-student relationships as well as advancing students' understandings of science concepts). Nonetheless, one fourth-grade teacher wondered whether excessive use of engaging oral strategies could have negative social implications such as making students who were used to a more authoritative teacher role feel puzzled and uncomfortable.

Like Mrs. Nichols, several educational researchers have pointed out that younger students may be unable to comprehend non-literal meanings in teachers' figurative

expressions, arguing that primary teachers need to become more aware of the non-literal expressions they frequently use in their classrooms, monitor their students' comprehension of such linguistic forms, and adjust their language to mach students' linguistic and cognitive abilities (Kerbel and Grunwell 1997; Lazar et al. 1989). Mrs. Nichols' negative perception and the low frequency of her employment of engaging oral strategies (the lowest of all three teachers) suggest a high level of awareness of the potential cognitive challenges that figures of speech, parallel repetition and engaging questions can pose to younger children. Furthermore, the fact that her kindergarteners were not confused by her few figurative directives (as evidenced by their immediate compliance) provides evidence that such engaging oral strategy, when carefully and skillfully employed by the teacher, can serve important social functions and thus enable effective classroom management even in kindergarten.

Implications

The findings in the present study have both scholarly and practical significance. This study makes an important scholarly contribution to the science education literature by highlighting the multiple social and cognitive functions of elementary teachers' oral practices as well as their varied perceptions of such practices. Furthermore, it provides elementary teachers with a number of oral strategies that they can strategically adopt to improve their facilitation of guided science inquiry discussions.

As indicated by Appleton (2007) in the Handbook of Research in Science Education, most of the elementary science education research conducted in the last decade has actually focused on the middle school. In Appleton's own words "there clearly needs to be more research into science in the early grades, especially to explore… theoretical frameworks for research… and pedagogy to enhance learning" (p. 527). The present study begins to answer this call by identifying, through the adoption of multifunctional theoretical framework, a set of engaging oral strategies that teachers can employ both socially and cognitively in their own classrooms.

A large number of research studies have shown that science teachers in varied grade levels often use analogies and metaphors to explain science concepts to their students (Duit 1991; Glynn 2007, 2008; Treagust et al. 1992; Treagust et al. 1998). However, this body of research has focused exclusively on the cognitive functions of teachers' analogies and metaphors (e.g., connecting and comparing concepts). The present study adds to this particular literature by underscoring that science teachers' figurative repertoire is in fact much larger and that their speech figures also serve important social functions.

The language of science classrooms has been shown to be often too dull, formal, humorless, and focused on authoritative and objective facts, alienating students from science and making it more difficult for teachers to communicate with pupils effectively (Lemke 1990). Teachers need to adopt more "humanized" or colloquial ways of talking science to make classroom discussions more interesting, familiar

and accessible to students. Such findings and arguments underscore the importance of teachers' engaging oral strategies. In resorting to figures of speech, parallel repetitions and engaging questions, teachers can speak a language that is more comfortable, appealing and familiar to students, thus making science a more humanized and accessible topic to children engaged in guided inquiry discussions.

Limitations and Future Research

An important limitation of this study is that it focuses almost exclusively on the teachers' perspective, that is, the oral strategies teachers adopt while facilitating guided science inquiry discussions. The student perspective—how they participate and contribute to these discussions as well as how they are affected by their teachers' engaging oral practices—is for the most part overlooked. Because the video-camera was focused primarily on the teacher, the video-recordings contained more nonverbal information (face expressions, gestures, postures) about the teacher than her students. Likewise, the sounds captured with the wireless microphone provided detailed information about the linguistic features of teachers' utterances (their tone of voice, pitch), whereas the contents of students' statements were often difficult to hear due to interruptions, overlapping, and pupils' limited communicative skills. As a result, it was not possible to explore the resulting levels of student engagement, pupils' comprehension of non-literal language as well as their recall of the content of science discussions. Future research will need to attend to this important limitation. Lemke (1990) describes how trained observers can gauge relative levels of class engagement in a lesson by keeping track of visible signs such as number of students looking at the teacher, reading the board, taking notes, talking to neighbors, staring out the window, reading a comic book, etc. Furthermore, researchers can explore students' comprehension of non-literal language and content recall through interviews and written knowledge assessment instruments. Such research is likely to provide educators with valuable insights on the nature and overall effectiveness of the oral strategies employed by elementary teachers to engage young students in guided science inquiry discussions.

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