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Power in the Classroom: How the Classroom Environment Shapes Students' Relationships With Each Other and With Concepts

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Changes in participant structures in classroom environments are often examined in terms of their effects on student learning. In this study, we proposed a way of examining participant structures in terms of power. According to Wertsch (1998) "the emergence of new cultural tools transforms power and authority" (p. 65). When researchers or teachers introduce new tools into classrooms including new participant structures, they create the potential for transforming many relationships of power: between students and teachers, among students, and between students and the material being studied. Using data from a 6th-grade classroom involved in a science unit, we consider how these transformations of power play out. In considering the role of participant structures, we look at how a match between the participant structures and the structure of the discipline can positively affect these relationships of power.

Giving students the means of approaching the discipline of science as scientists do requires equipping the classroom with activities and means of participating that give students access to scientific ways of thinking (Driver, Newton, & Osborne, 2000). In recent years, researchers have proposed and evaluated new classroom "participant structures" (Phillips, 1972) that afford students opportunities to meaningfully participate in the "doing" of science (Herrenkohl & Guerra, 1998). Such studies have worked to overcome the barriers of traditional classroom participant

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structures wherein the teacher does most of the talking and students participate by responding to teacher questions and receiving evaluations on their responses (Cazden, 1988; Mehan, 1979). Researchers in the area of science inquiry are attempting to move beyond this participant structure, which Bruner (1960) termed a "middle language" of science learning, to structures that involve having students actually "talk science" (Lemke, 1990) and participate in the process of inquiry.

The pedagogical moves involved in implementing these new participant structures in science classrooms are typically analyzed in one of two ways. First, researchers look at the nature of the participant structures in terms of the social changes and related discursive practices (Palincsar & Brown, 1984; Polman & Pea, 2001; Tabak & Baumgartner, 2004/this issue). Encouraging active participation in learning and creating classroom environments where all voices can be heard has become an important goal for transforming participant structures in itself. In addition to this goal, researchers have followed a second major implication of classroom participant structures, that is, how particular structures directly support and enable discipline-specific learning (Herrenkohl & Guerra, 1998; Lampert, 1990). This consideration comes from a growing body of evidence that disciplinary-specific ways of thinking can and should be represented in the teaching of school subjects (Bruner, 1960; Shulman & Quinlan, 1996).

In this article, we put forth a new type of analysis, one that considers both the changes in social interactions that new participant structures bring forth and also the way that these structures enable and incite disciplinary thinking: in our case, scientific thinking. We see these two ends as possessing a common link: a change in the relationships of power in the classroom. According to Wertsch (1998), "the emergence of new cultural tools (i.e. new participant structures) transforms power and authority" (p. 65). As a new participant structure is enacted in a classroom, this creates the potential for transforming many relationships of power, including the relationships among members of the classroom and the relations between students and the subject matter being studied. We believe that all of these changes are highly interrelated and dependent on one another. Further, we believe that looking at participant structures in terms of power allows an effective means for analyzing why some structures are more successful than others, why certain students may "appropriate" the structures more readily than others, and why some structures may be better suited to certain disciplines than others.

To pursue this kind of analysis, we first need to set out our definitions of participant structures, "cultural tools," and power. In our analysis, we broaden the concept of participant structures somewhat to include what other authors have termed "participant frameworks" (Goodwin, 1990; O'Connor & Michaels, 1996). The concept of participant frameworks combines an interest in conventional classroom social arrangements including concomitant rights and responsibilities (or what is often called participant structures; Au & Mason, 1981; Erickson, 1982; Phillips, 1972) with the notion of "social positioning" or the ways in which particular dis-

cussions within participant structures linguistically place speakers in relation to subject matter and other classroom participants (Goffman, 1974). This concept allows one to recognize the dynamic relations between planned structural features of the classroom and the many kinds of discussions that can emerge within these purposefully chosen classroom arrangements. As Goffman's (1974) work suggests, speakers linguistically bring into focus a particular set of possible relationships. This is an important aspect of our analysis. Although we use the term participant structure throughout in this article, we intend it with these broader conceptions of classroom structures and interactions in mind.

Using the idea of cultural tools in this analysis, we attempt to move beyond research that explains behavior solely in terms of individual contributions. In doing so, we adopt Wertsch's (1991, 1998) view of cultural tools as historical, cultural, and institutional mediators of human action. Wertsch (1998) placed cultural tools or "mediational means" at the center of analysis, describing individual action in terms of the tools used to carry out that action. In typical description of classroom interaction, the cultural tools that students work with are placed at the periphery; the focus is instead on what individual students are capable of doing and how students relate to each other. Our analysis focuses instead on the ways in which cultural tools create and transform these relationships and how such tools mediate disciplinary engagement.

The word *power* carries strong connotations, so we first define what we do and do not mean by power and then discuss our rationale for using power as our unit of analysis in this study. First, we do not see power as something exterior to the process of learning. Foucault (1999) supported this view of power, stating that relations of power do not exist in a "position of exteriority with respect to other types of relationships" (p. 476). Similarly, as articulated by Foucault, we assert that power does not exist in any one form, nor is it imposed from the "top down." This conception of power differs from the way that people typically conceive of it: as something that an external force or institution or government imposes on us or as something that certain groups or individuals inherently possess. Whereas we do talk about power in terms of some people being more "powerful" than others in a given context, we do not view this as a stable attribute of individuals or institutions. In contrast, we conceptualize relationships of power as existing on a balance scale, with situational factors causing the positions of persons in an environment to constantly shift and change with the potential of being tipped in different directions. Like Foucault, we see the nature of power as "strictly relational" and as containing "many points of resistance" (p. 477). In an educational setting, this means that manifestations of power could be found in any interaction or relationship.

Wertsch (1998) saw power similarly as an inherent part of any setting. Wertsch described power as typically defined in terms of the "attributes of the individual agents" (p. 64), a focus that can tell one only who has power. A sociocultural approach, as proposed by Wertsch, examines the ways in which cultural tools influ-

ence the relationships of power between people and, as stated previously, how "the emergence of new cultural tools transforms power and authority" (p. 65). As we adopt this view of power as something that exists not within a person but within human relationships mediated by tools, we must develop new vocabulary for explicating the locations of power in interactions and for conceptualizing the dynamic ways in which persons and tools influence each other in sociocultural settings. We have identified three such conceptualizations of power in the literature that relate to classrooms and education: (a) ownership of ideas, (b) partisanship, and (c) persuasive discourse.

The term *ownership of ideas* implies a relation of power between the individual and a concept. The idea was originally defined in sociological work, which describes the relation that a corpus of knowledge has to a particular group of people or constituency (Sharrock, 1974) but has been expanded on in educational literature (Engle & Conant, 2002; Goodnow, 1990). In his conception of ownership, Sharrock (1974) stated that it isn't particularly important which members of the constituency hold the particular knowledge; it is only important that they are perceived as being owners of it. In education, this idea constitutes a major component of power in that whomever students perceive as having ownership of an idea—either themselves, their teachers, their textbooks, or their peers—will influence the relation that the student has to the idea itself. Perceptions of who owns particular knowledge could simultaneously affect a student's relationships to other people. If a student sees the teacher as the owner of a concept, for example, the teacher may also be perceived as more powerful to the student. Goodnow made clear how our relationships with knowledge and with others in our environment are tied up in each other. Goodnow's work explores how ideas are not value-neutral and stated that the acquisition of knowledge involves knowing the restrictions or guidelines that are placed on the knowledge by the culture. As a specific example of this, Goodnow stated that knowing which "areas of knowledge belong to some people more than others" (pp. 264–265) becomes a central determinant of the kinds of learning in which children will engage.

The term *partisanship* describes relationships of power among students that can develop through their interactions with concepts and with each other. Hatano and Inagaki (1991) found that students in science discussions tended to argue for a particular side, showing "signs of solidarity" to students they agreed with and "pointing out errors in reasoning" for the other side (p. 340). The basis for students' taking sides, according to Hatano and Inagaki, is not always a function of their individual understandings of the material. Preexisting relationships among students can influence these lines of solidarity. As Lensmire (2000) cautioned, even in the most open and democratic classroom environments students can develop alliances against more "powerless" groups, namely, students of lower social and economic status. However, it is conceivable that if students view themselves as owners of particular ideas as described previously, then the lines of partisanship could fol-

low students' understandings or representations of the material rather than the more harmful social alliances that Lensmire describes. In either eventuality, relationships of power can develop among classmates as certain students become champions for particular ideas and work to gain support and agreement from their peers.

A third conceptualization of power, *persuasive discourse,* relates the idea that certain ways of communicating can in themselves affect the relationships of power among people. Internally persuasive speech, according to Bakhtin (1981), allows the recipient of a message to accept the speaker's word in part and compare it with his or her own knowledge. The recipient is placed in a higher position of power relative to the speaker in that he or she ultimately decides what part, if any, of the message to believe or adopt. In contrast, authoritative discourse "binds us, quite independent of any power it might have to persuade us" (p. 342). Authoritative discourse requires people to passively accept the word of another without contemplation of how it fits in with other things that we know or how it fits in with other things that the speaker has said. The context in which the speech occurs also influences the relationships of power that each of these styles of discourse affords. In academic settings, for instance, one normally expects scholars to utilize internally persuasive speech in conveying their ideas to one another; the relationship of power that authoritative discourse creates would not be acceptable among colleagues who would view themselves in a more or less equal relationship in terms of power. In traditional classrooms, however, one typically sees teachers using a more authoritative style of speech. Cazden (1988) and Mehan's (1979) description of initiation–response–evaluation (I–R–E) sequences in classrooms illustrates this point: because the teacher's charge is to evaluate student responses, one can infer that he or she has assumed some role of authority over the subject matter content.

Looking at these three aspects of power, we can begin to analyze the relationships among students, teachers, and ideas that exist and that we, as researchers, attempt to create in classrooms. The aspects of power—ownership of ideas, partisanship, and persuasive discourse—reflect different relationships that exist in classrooms (between students and concepts, among students, and between students and teachers) that should be considered alongside each other. An analysis of classroom interactions on these terms allows us to simultaneously consider the tools that students use, the participant structure, and the disciplinary learning that we observe. This link not only benefits our research purposes. It makes sense to consider the way these things interact in the complex, real lives of students and teachers.

In this study, we look at how a variety of cultural tools were implemented in a classroom as part of a large science unit and discuss how these various relationships played out within that context. Based on our data, we propose specific ways in which the three aspects of power manifested in various relationships within this

learning environment and then later discuss how these relationships differ from those found in typical classroom participant structures. A link between the tools and the interactions observed will continually be kept in mind as we explore students' experiences.

METHODS AND DATA SOURCES

This study took place with a subset of data from a larger study called Promoting Argumentation in the Teaching of History and Science (PATHS; Stevens, Wineburg, Herrenkohl, & Bell, under review). Two 5th and two 6th-grade elementary classrooms participated in the project. This study uses data from one of the sixth-grade classes. To examine the ways in which the relationships of power manifest through participation in a particular science unit called "Sinking and Floating," we analyzed the videotaped classroom lessons and interviews of two students following the unit. Our focus on interviews serves the purpose of matching students' own perceptions of power relationships with the ways that they actually engaged in the context of their classroom activities. The two focal students were active participants in classroom discussion as well as articulate interviewees who spontaneously reflected on their ideas and their classroom-based discussions. These students' reflections on their experiences during this science unit were used to propose various ways in which power may be understood in this particular classroom environment. We draw on examples from the classroom when they help clarify points raised by our two focal students. Our reasons for choosing these two particular students for a case study are discussed further in a later section.

PATHS PROJECT

The main purpose of the PATHS project was to explore students' epistemological understandings of history and science and to find ways that pedagogical structures in the classroom could foster connections across these seemingly disparate disciplines. The project utilized a curriculum that aimed to help students understand how to think like historians and scientists. Toward this end, two units of science, two units of history, and one unit that combined both disciplines to study a single topic were explored in the classroom. In both subjects, students were either given documents or experiments to uncover pieces of information from which they created their own theories in small groups.

One main link between the disciplines of history and science, as stated in the title of the project, is argumentation. This commonality was not only something that teachers discussed with students; it also shaped the way that students and teachers interacted with each other during the units. After students worked in small groups

to build their own theories, for instance, they subsequently presented and defended those theories in front of the class. The class then attempted to build an understanding of the issues together.

The science unit used as the focus of this study, the Sinking and Floating unit, consisted of a series of experiments in which small groups of students (a) predicted whether certain objects would sink or float, (b) tested the objects in buckets of water, (c) recorded their results, and (d) created and revised theories based on these experiments. The experiments implicated the concept of density, although the teacher did not introduce this term in class herself. The mystery of why some things sink and others float was discussed in whole-class discussions as small groups presented their theories and justifications for why they believed certain theories over others.

We emphasize here that the main purpose of PATHS was to explore students' understandings of the intellectual work in which historians and scientists engage and to assess the extent to which they would utilize these ways of thinking when given adequate disciplinary tools. Although we do find it equally important that students reach deeper understandings of the subject matter content (i.e., the concept of density), the measures that were devised for our research purposes tapped students' understandings about the discipline itself. In science, for instance, our premeasures and postmeasures assessed students' ideas about "theory," "experimentation," and about disagreement in scientific communities. Likewise, many of our interview questions attempted to uncover students' epistemological understandings of the discipline of science. Although our students' conceptual development around the topic Sinking and Floating deserves our consideration, this concern is not central to our claims in this article, and we postpone an analysis of what students learned about the subject matter content until the discussion section.

CULTURAL TOOLS IN PATHS

The PATHS project introduced a number of new cultural tools into the classroom, all of which were attempts to model different aspects of disciplinary thinking. One tool, which the small groups used to organize their scientific arguments, was a SenseMaker board. The SenseMaker boards in the PATHS classrooms were adapted from a software argumentation tool that allows students to make their thinking visible (Bell, 1997, 2004; Bell & Linn, 2000). The board provided visual space on a large whiteboard for students to order the sinking and floating objects and record their predictions, results, and theories for the first three experiments in the Sinking and Floating unit. During group presentations, the SenseMaker board also served as a poster, which allowed students to share their ideas visually with the whole class.

A second important cultural tool in this unit was a "thinking like a scientist" poster. This poster, borrowed from Herrenkohl and Guerra (1998; see also Herrenkohl, Palincsar, DeWater & Kawasaki, 1999), explicated some of the processes that scientists go through in creating theories. These processes included (a) predicting and theorizing, (b) summarizing results, and (c) relating predictions and theories to results. Throughout the science unit, this poster was displayed in the classroom, and the teacher reviewed these strategies both before students began their small-group work and before the groups presented to the class.

A third element adopted in the PATHS classroom was Herrenkohl and Guerra (1998) and Herrenkohl et al.'s (1999) use of audience roles for scientific discourse communities. The audience roles corresponded to the three strategies listed previously for thinking like a scientist, and audience members rotated daily through the different roles during group presentations. According to Herrenkohl and Guerra (1998), audience roles serve the function of transforming student participation by helping students to "assume the intellectual roles in the context of the whole class reporting" (p. 455) and diminishing the role of the teacher as questioner.

On the first day of group presentations, the teacher assisted the class in developing another cultural tool to aid classroom discussions, the "questions chart." With the teacher's guidance, students anticipated what types of questions they might need to ask of the presenting group to better understand their theory and methods. As a class, they generated lists of potential questions for each of the audience roles: predicting and theorizing, summarizing results, and relating predictions and theories to results. The presence of this questions chart during whole-class discussions aided audience members in asking appropriate and relevant questions if they needed assistance.

Last, the class used a forum-style discussion format during whole-class presentations. Group presentations resembled science convention presentations in that each group presented their predictions, method, results, and theories, and members of the audience asked clarifying questions and sometimes challenged the theories and assumptions of the presenting group. The presenting group held the responsibility of calling on their classmates who had questions or comments. Each group presented and discussed their results and theories for an average of 15 to 30 min, with some groups taking up to 45 min when discussion around debated topics could not be easily resolved. This tool, along with the use of audience roles, modified the participant structure during whole-class presentation time by transforming the roles of audience members from passive listeners to active participants in the creation of meaning.

As is evident in the previous paragraphs, our use of the words cultural tool includes a range of things from what some would label as participant structures to what some would label as curriculum or "instructional aids." Despite their differing functions in the classroom, or perhaps because of them, we include all of these cultural tools in our analysis of the relationships of power that developed.

Neglecting any of these pieces as a contribution to the power dynamics in the PATHS classroom would be to distort the picture of complexity that exists in such an environment.

PARTICIPANTS

This study took place as part of the PATHS project in an elementary sixth-grade classroom. The school is located in a diverse urban school district; in this particular classroom, approximately 50% of the students came from a nonmajority background, and approximately 27% of students received free or reduced lunch. The teacher, Mrs. Garrett, had been teaching 4 years at the time of the study. Mrs. Garrett described her style of teaching as "balancing inquiry and exploratory based [instruction] with the scaffolding [students] need to have the skills to be able to do that." When students asked questions during class discussions, Mrs. Garrett commonly threw the question back out to the student or to the whole class to get them to think about how to answer it on their own. When a student struggled to articulate an idea, Mrs. Garrett often encouraged a "think aloud" whereby the student can try to make sense of ideas in a public space. According to Mrs. Garret, the curriculum supplied by the PATHS project as part of the research project matched her own philosophy of teaching and she liked the fact that "the answer was never just given."

We focus our analysis of power around two students in this classroom environment. Although we acknowledge that the cultural tools used in the classroom can affect different students in different ways (an interesting discussion in itself concerning issues of power), we are concerned in this article to explicate how two particular students related to their environment. The two students chosen for in-depth analysis in this study were selected for the following reasons: (a) the explicitness of their reflections during interviews following the Sinking and Floating unit on the social and cognitive factors that affected their learning; (b) the external nature of their thinking during class discussions, which allowed their understandings of sinking and floating to be closely traced; (c) their relationship to one another in the process of reaching an understanding about the concepts involved in the unit; and (d) the extent to which these two students could be described as powerful in the context of this particular unit.

Alicia, a Euro-American girl whose family had resided more than 10 years in the school district, and Alex, a Korean boy whose family immigrated to the United States just 3 years before the time of this study (his parents spoke little English), are the two sixth graders in Mrs. Garrett's class that we follow in this analysis. The two define themselves as friends, and they acknowledged in their interviews their long-standing tendency to argue with one another. In the Sinking and Floating unit, Alicia and Alex were originally placed in separate groups, and they had developed different theories about why things sink or float. In whole-class discussions, these

two tended to be the most outspoken about defending their theories, which for both were still incomplete until the end of the unit. Alicia seemed to fluctuate the most about her theories and began early on in the series of experiments (which took place over more than a week) to locate outside information to help her solve what she saw as a puzzle. Several of her early attempts at understanding what books had to say about density failed, however. In an effort to demonstrate for the class an explanation she had found in a book, "if an object weighs more than the water surrounding it, it'll sink," Alicia filled up one bucket of a pan balance with water and placed a small sinking and floating object in the other. Mrs. Garrett allowed Alicia to try out her idea in front of the class and watched from the audience as Alicia tried to explain her theory. When the demonstration failed to support her, she retreated from her claim but continued to pursue the solution on her own.

Alex struggled with competing explanations for why things sink and float throughout the class presentations and discussions as well. His strongest two opinions were that the shape (meaning the surface area) of an object matters in sinking and floating and that materials matter. As other groups presented, however, Alex began suggesting that perhaps "everything matters" only "some things matter more than others." Alex initiated his own experiment toward the end of the unit to show that different shapes of clay, which were the same weight, would produce different sinking and floating results. At the end of the unit, Alicia and Alex decided to continue their exploration into these ideas and work together to find out, in a sense, whose theory was right.

TEACHER'S ROLE IN THE CLASSROOM

We present the findings in this article with a focus on the relationships of power in the classroom as perceived and experienced by Alicia and Alex. By adopting this focus, however, we do not mean to suggest that the teacher had no role in shaping the learning experiences of these two students and the rest of the class. On the contrary, the teacher's support of student learning was instrumental in creating the relation of power between the student and the subject matter and in transforming the participant structure of the classroom. We list briefly here some specific (but by no means exhaustive) ways in which Mrs. Garrett's instructional practice furthered the goals of social and disciplinary engagement in classroom knowledge-making discussions. We draw on the four major principles proposed by Engle and Conant (2002) for fostering productive disciplinary engagement in classrooms as a framework for this discussion.

Problematizing Content

According to Engle and Conant (2002), problematizing content in ways that represent the true nature of disciplinary-specific inquiry requires some intentional

moves by the teacher. Namely, teachers should encourage "questions, proposals, challenges, and other intellectual contributions" (p. 404) from students. The teacher's approach to the problems raised either by herself or by the students frames intellectual work as a process of using and building on prior knowledge. This conception of teaching is supported by others (Lampert, 1990; Lemke, 1990; O'Connor, 2001; Polman & Pea, 2001; Rogoff, 1990) who have defined the teacher's role as one of support and clarification for students' ideas rather than one of validating students' responses. Mrs. Garrett was quite adept at encouraging the ideas and questions that students raised throughout the course of the Sinking and Floating unit. She frequently "revoiced" students' questions and comments (O'Connor & Michaels, 1996) to make sure the contributed ideas were understood by the entire class as well as the speaker. Some examples of this from the 3rd day of Sinking and Floating include statements such as "were you asking about if they had disagreements with the predictions?" and "you keep saying that you misjudged the weight. Does the order in which you put those things change?" This type of questioning promoted student explanations and left room for further student questioning and inquiry.

Giving Students Authority

Effectively problematizing the content of the subject matter requires giving students the authority to conduct such investigations (Engle & Conant, 2002). To give students authority, a teacher must treat them as contributors and allow them to be active participants in classroom discourses (Lensmire, 2000). Mrs. Garrett consistently referenced ideas in class as belonging to their respective individuals or groups, asking presenting groups what their theory was and how that theory changed after they completed the experiments. At the end of the unit, when Alicia brought in a page of notes from research she had done at home on density, Mrs. Garrett presented this to the class as "Alicia's idea" and then turned the floor over to Alicia to explain it. By identifying ideas in this way, students were positioned as stakeholders in their own understandings of the content.

Holding Students Accountable to Others and Disciplinary Norms

Opening up the classroom for questions and contributions from students does not mean creating a learning experience in which anything goes. Holding students accountable to disciplinary standards of inquiry and to fellow students' contributions and ideas constitutes much of the work that teachers in this type of learning environment must accomplish (Engle & Conant, 2002; Herrenkohl & Guerra, 1998; Lampert, 1990). Mrs. Garrett reminded students of these standards periodically throughout the unit, reiterating the image of science as a process of coming to under-

stand the world. This example from Day 4 shows how she helped one student, Tyson, construct a more thorough, scientific explanation to a fellow student's question:

> Teacher: Do a little think-aloud. Felicia, ask your question again, and Tyson, don't be afraid of being wrong. Who cares if you're wrong? You might be, and oh well, you know what we're-, we have theories. Just talk it through and see what you think. Cause if that's your theory, you've gotta be able to back it up.

In this statement, Mrs. Garrett held Tyson accountable not only to the norms of science, which require convincing evidence to support theories, but also to his classmate Felicia who deserved an adequate answer to her question. By supporting the conversation in this way, the teacher fostered more productive discussions around the topic.

Providing Relevant Resources

Most of the resources needed for the Sinking and Floating unit were anticipated and provided by the PATHS research team, so a lengthy discussion of the teacher's role in doing this is not necessary. As Engle and Conant (2002) stated, however, one of the most fundamental resources that this type of disciplinary engagement requires is time. In allowing this, Mrs. Garrett played a significant role. Each group was given ample time during whole-class discussions to present, answer questions, and revise their theories if necessary. The average group presentation time was 30 min, with the shortest being 18 min and the longest 33 min. Each student question was likewise afforded an adequate amount of time and attention by the teacher.

We have described just a few of the many important ways in which the teacher in this classroom played a role in supporting student learning. Although the teacher's specific pedagogical moves are not the focus of our analysis, this depiction helps one to understand the classroom context and the ways in which the cultural tools were framed and utilized. Explication of the teacher's role during discussions also supports the interpretation of our research findings and helps us to understand how and why power was located where it was. We turn now to these findings from our interviews with Alicia and Alex following the Sinking and Floating unit.

FINDINGS

In interviews following the conclusion of the Sinking and Floating unit, Alicia and Alex were both asked about their experiences with one another, their classmates, and with the subject matter. Excerpts from these interviews have been analyzed us-

ing the criteria from the three aspects of power that were described previously: ownership of ideas, partisanship, and persuasive discourse. The interview clips showed how these two students perceived and participated in relationships of power in their classroom during the science unit. For each aspect of power, we include an analysis of the cultural tools that were used and how they contributed to the formation of the various relationships of power.

Ownership of Ideas

As the class prepared to begin the experiments for the Sinking and Floating unit, Mrs. Garrett reviewed the thinking like a scientist poster (in her words, describing science as a "circular process") and introduced the SenseMaker board as a tool they would use to keep track of their experiments. From there, student groups worked largely independently in carrying out the experiments. The framework provided by the SenseMaker board included a place to order the objects along different dimensions, columns for predictions and results, and a space to write theories before and after the experiment scaffolded the process of experimentation for the student groups. The diminished role of the teacher during this time and the use of the SenseMaker board required students to come up with their own theories about why things sink and float. This new cultural tool within the participant structure of small groups reduced the feeling of knowledge belonging to others to a minimum for both Alicia and Alex. Both gave indications in their interviews that they viewed the ideas they employed in the Sinking and Floating unit as mostly belonging to themselves:

> Alicia: We had to make up our own theories. We had a bunch of different ways to think of, uh, the prob-, the answers, the problem, or the question. You guys threw out a bunch of different things and we were supposed to take our evidence and our facts and our experiments. We were supposed to find one theory.

Alicia's repetitious use of the word *our* in describing the important points from the unit shows that she did not view the answers to sinking and floating as knowledge that belonged to someone else. Although she acknowledged the researchers' and the teacher's role as "you guys" who provide the materials and activities, she perceived her own role as the one who creates the knowledge from these disparate "things." In another statement, Alicia indicated her own reaction to this process:

> Alicia: Well, first when we were doing the weight, I really thought it was, like, just like everybody else, that it was only the weight that mattered. And then we started doing volume and I started, my *own ideas* [italics added] … started changing as, and I was like, wait a

> minute, this is much bigger than weight. And so I went and looked it up. [laughs] Cause I wanted the answers."

Again, in this statement, Alicia indicated ownership over her "own ideas" and related how the discrepancies between different experimental results motivated her to seek out more information. It is important to note here that she perceived her own ideas as existing before she even sought out information from other sources. One could interpret this quotation as indicating that Alicia had given up on her own ideas and simply wanted the easy answer to this problem (something students are typically expected to do during the school day). However, analyzing this quote alongside evidence from classroom data shows that Alicia sought answers that would serve her own understanding. Alicia's first encounter with an outside source (described previously) resulted in her failed demonstration with the bucket of water and the small sinking and floating object. As this demonstration did not prove helpful in explaining why things sink or float, she continued to research until she found information that she could verify with her own experiments. Alex's responses indicate a similar attitude:

Interviewer:	So I heard that you and Alicia did some research on your own. …
Alex:	Uh-huh.
Interviewer:	… How did you guys do that? You were looking up information. Where did you look?
Alex:	We looked in the internet, and our parents, and yeah. …
Interviewer:	You asked your parents?
Alex:	Yeah. Well Alicia was doing it on the book.
Interviewer:	Mm-hmm.
Alex:	Encyclopedias.
Interviewer:	Did you feel like, that that was an easier way to find out the answer than to do the experiments?
Alex:	Not really, cause we can't really trust the encyclopedias, cause maybe, it could be wrong too.
Interviewer:	Uh-huh. What about parents?
Alex:	Well, we, she, they were kind of little on our, like, decision.
Interviewer:	Hmm.
Alex:	Cause I don't think they know much as, uh, encyclopedias or internet, so … they did, they still, [they were] right though.
Interviewer:	What do you think you would trust the most? To prove, to prove your theory?
Alex:	Well, I don't know, like either ourselves, or, no, or encyclopedias.

This excerpt shows that Alex believed his own observations and experiments were valid ways to evaluate his theory. Alex did not view sinking and floating as a prob-

lem to which others would necessarily have the answers. Although he acknowledged the possibility that others (parents or sources on the Internet) might know, he still placed his own ideas on equal footing with the information that he could find in an encyclopedia. Other statements that Alex made indicate similar feelings of ownership and competence in theory building:

Interviewer: So what was your theory?
Alex: My theory is that everything works, everything does matter, except some of them matters more than others.
Interviewer: Okay. Like, what do you mean by everything?
Alex: Like weight, density, volume, shape, size.
Interviewer: Okay.
Alex: Material.
Interviewer: Material. Uh-huh. And if you had to put them in order of what matters more than the other ones, could you do that?
Alex: Yeah. I'd have to test it a lot though.

Alex related a very clear conceptualization of his final theory from the Sinking and Floating unit. The interviewer's question, "what was your theory?," elicited an immediate response from Alex, as if the interviewer had just asked him to describe his best friend or his favorite hobby. Alex was used to thinking of the theory as his. In his last statement, "I'd have to test it a lot," Alex further indicated ownership over that idea in that he perceived himself as capable of further changing and reworking the theory. In contrast to students' typical encounters with the discipline of science, Alex viewed the ideas in Sinking and Floating as accessible and as a process of coming to an understanding rather than as a product of someone else's discovery.

Ownership of ideas, in our use of the term, goes beyond a student's claims of authorship for some product he has created in school. Certainly, students in traditional classroom settings also feel a sense of ownership and pride over their ideas and products, but we mean more by ownership than this. As shown in the preceding interview clips, ownership of ideas for Alicia and Alex went beyond claiming a theory or an idea as "mine." This is part of it, but what is more spectacular is what ownership in this sense enables the student to do. In taking ownership over an idea or concept, the student perceives a higher degree of flexibility in using it, in asking questions of it, and sometimes (as in Alicia's case) in dismissing it when it fails to explain observable phenomena. The following excerpt from the last day of classroom instruction around the topic of Sinking and Floating shows this flexibility in action:

Alex: Mrs. Garrett. What if we have more than one theory? Like what if you were saying that all of the stuff does matter?
Researcher: Could your theory have multiple parts?

Alex: Yeah. Like you were saying that … the thing that you just wrote. And the weight and the … like everything matters. Except there's like an order. What if it's like that? How can you test that?
Teacher: Alicia.
Alicia: Um, okay, let me help you with that section you described. Okay, um, if, let's, okay, let's say then if you used, uh, same sized object, same shape …
Teacher: Come and grab [the objects]. There's stuff up here that's the same size, the same shape.

Because Alex owned his own understanding of the issues that have been discussed up until the last day of the unit, he was able to further question the ideas that he himself had heretofore developed. As he began to sense that his "everything matters" theory might in some ways be inadequate, he sought out explanations to further refine the theory. Alicia, who had recently finished her own research on the concept of density, fielded the question that was actually intended for Mrs. Garrett and began to fashion an explanation for Alex for how he might control variables to reach his answer. Students in classrooms with more traditional participant structures might not have the opportunity to work with concepts in this way because the teacher's evaluation of the student's idea could reclaim ownership of that idea and take the further refinement of it out of the student's hands. As is seen in the clip, Mrs. Garrett did not do this, but rather supported the students in addressing each others' questions with their own unique explanations. By owning their ideas, their theories, Alicia and Alex, in this sense, became more powerful than students in traditional classrooms.

Partisanship

The presence of partisanship in the classroom conversations extended from students' ownership of ideas in that the students with the most strongly owned ideas tended to lead the class in discussing their particular theories. The forum-style science presentations, along with the audience roles and questions chart, created participant structures in the classroom in which students were allowed and encouraged to question each other's thinking and theories. As Herrenkohl and Guerra (1998) put it, this was both a "right" and a "responsibility" that students had when participating in the audience. Through the process of questioning each other's theories, students supported and opposed each other's ideas. Alicia reflected on the dynamic of partisanship that she perceived throughout the whole-class discussions that occurred during the participant structure of whole-class group presentations:

Interviewer: Was there anyone that you agreed with?
Alicia: Uh. Basically, what we did was we argued and some people agreed with me and some people agreed with Alex, so we kind of

> took sides. And so, and my friend Aaron, I got a, I agreed with him a lot. But he was on, like, both sides.

Alicia's comments show how she and Alex became champions for different "sides" of the debate during the Sinking and Floating unit. The cultural tools mentioned previously and the participant structure during the whole-class conversations set up a situation in which Alicia and Alex could try to win the agreement of their classmates. Signs of solidarity (Hatano & Inagaki, 1991) from classmates obviously held importance for Alicia; at the time of the interview, she remembered quite well who agreed with whom throughout the unit. Alex also commented on the dynamic of participation during whole group discussions:

> Interviewer: So what did you think was hard about the unit?
> Alex: A lot of arguments and….disagreements.
> Interviewer: Why did you think that was hard?
> Alex: Cause everybody has their own opinions, and we just, we can't just decide one thing, cause some people disagree.

Alex's picture of whole-class discussion time resembles Alicia's in its depiction of disagreements between students, but judging from Alex's comments, he did not perceive the partisan motivations of his classmates as strongly. Alex talked about students as each having their own opinions and ideas about the unit and did not comment on how students aligned themselves with particular perspectives or with particular spokespersons for those ideas. The reason for this may lie in the behaviors of students such as Aaron who Alicia described as being "on both sides." Whereas Alicia noted the importance of another student being on her side (if only temporarily), Alex seems to have viewed other students as possessing their own independent ideas that did not align with his or Alicia's. Alex's comments do indicate, however, his perception of difficulty in trying to get classmates to go along with an agreed on theory whether it is his own or someone else's.

Whether perceived as important by individual students or not, partisanship shaped the experiences of these two students through their relationships to each other and to their classmates. Both refer to the difficulty of getting people to agree in the context of whole-group discussions, and both students lobbied for the acceptance of their own ideas throughout the course of the unit. For example, on the last day of instruction, Alex was looking around the room for some clay to do a demonstration. When Mrs. Garrett asked him why he wanted to use it, he responded, "To prove my theory. I *want to show them* [italics added] that it [volume] does matter." The cultural tools and participant structures that minimized the presence of the teacher in the class as an authority and afforded these students opportunities to become champions for different ideas influenced their relationship of power to each

other and to the rest of their classmates; without affirmation from a number of peers, neither student could claim victory.

Partisanship can serve as both an affordance of and a constraint on the relationships of power between students such as Alicia and Alex, who hold their own particular well-developed ideas, and the rest of their peers. Because Alicia and Alex held such strong ideas about their theories and because the classroom supplied a relatively open forum for them to pursue these ideas in a public space, the two gained greater access to the floor during discussions. This created a classroom dynamic in which they each held more sway over the direction of the conversation than any of their classmates and not always toward positive ends for the other students in the class. One girl, Susan, for example, commented during an interview following the unit that Alicia and Alex dominated much of the classroom discourse throughout the unit, saying they "kept on fighting and I don't know why." Susan also expressed that she was sometimes confused by the conversations going back and forth between the two. Alicia and Alex's ability and willingness to banter back and forth about the intellectual content of the unit lowered the position of power of students such as Susan who found it difficult to even enter the conversation. Because of their desire to recruit partisan support from their peers, these students rose to a higher position of power in many instances throughout the unit.

However, these two students' relationships of power to the rest of their classmates was also constrained by their ability to derive this support. An example of this was found in the classroom data on the day after Alicia had first done some research on the topic of sinking and floating at home. Alicia told the class, based on her research, that if an object weighed more than the water surrounding it, it would sink. To prove this theory to the class, she filled up a bucket with water on one side of a pan balance and placed a small sinking and floating object in the bucket on the other side. When the demonstration failed to prove her new theory, her classmates expressed their lack of support. One student, Jeremy, critically questioned the source of her research. Alex suggested, "I think you read it kind of wrong." Alicia then backpedaled on her claim, saying "I could have gotten it opposite … I'll go check again." Because she could not convince her peers to go along with what she was proposing, Alicia lost the support to keep going with her idea and the conversation returned to a general discussion of the presenting group's theory.

The partisan motivations of students in Mrs. Garrett's classroom, as we have shown, have both positive and negative implications. Partisanship motivated deeper, prolonged discussions around the subject-matter content, which also involved many students besides Alicia and Alex who were engaged in supporting and challenging both sides of the argument. Yet on the other hand, the level of influence that Alicia and Alex obtained through their partisan efforts might not have proved helpful for the learning experiences of all students in the room. We address this very important issue in further detail following. For now, we summarize our

findings on partisanship by revisiting our criteria for considering both the social and disciplinary realms of the classroom.

Our observations of partisanship, as we have presented them previously, can be thought of as being mediated primarily through the subject-matter content, not through the teacher. That is, these students' bases for taking sides and arguing a particular viewpoint had more to do with wanting to develop their understandings about the principles of sinking and floating rather than social or status factors or their proclivities to want to "win" the argument or receive affirmation from their teacher. Other authors have described similar findings. Engle and Conant (2002), for instance, described a Fostering Communities of Learners classroom in which the discussions among students resembled "authentic scholarly practice, which often combines partisanship with a concern for developing better ideas" (p. 423). In more traditional classroom participant structures, represented by the I–R–E discourse patterns (Mehan, 1979), we can assume that this type of partisanship would seldom appear because it is in the nature of these types of classrooms that discussions of subject matter be mediated through the teacher. When the teacher enters into the discussion as an evaluator of statements and claims, she delegitimizes the whole basis for students' debate with one another. What would be the point in trying to convince your classmates that your idea has merit if the teacher would step in and solve the controversy with a simple yes or no?

Persuasive Discourse

In the preceding section, we described some of the difficulties that Alicia and Alex had in convincing their peers of their ideas. The cultural tools that created the possibility for students to gain power relative to their peers as spokespersons for ideas (e.g., forum-style science presentations), as illustrated in the previous examples, simultaneously created limitations on the relative power of these students. Alicia and Alex realized through this process of trying to attract partisan support of their theories that listeners have certain criteria for either accepting or rejecting a theory. Alicia's assertion that she "had done some research" and now had the answers to sinking and floating on its own did not convince her peers. As a result of these types of interactions, both students developed philosophies about how to best persuade someone else:

Interviewer: Well you said that a scientist needs to be able to know when they're wrong …
Alicia: Yeah.
Interviewer: How do you know when you're wrong?
Alicia: When the other person has a reasonable theory, and they have proof to back it up. And they can show you and it's more, you know, with the question you're following than yours.

Interviewer: So if someone else did some research and you read about it, and it looked like it might be a good theory, it might not be … how would you find out?

Alicia: I'd talk to them, and they show you, like … In class Alex said that shape doesn't really … [that] shape and volume are the same thing. That it, he took the clay and he flattened it and it had the same volume. And, uh, I kept going "No, no, no, you're wrong!" and trying to show him. And then Felicia came up and made little, a box with like little cubes and said, "Okay, these are 27 squares" and she flattened it out, and she's like "27 squares still." So, I was like, OK, I'm wrong.

In this interview segment, Alicia described an interaction between herself and two of her peers in which she was unable to persuade them that her assertion about volume was correct. Alicia's classmate, Felicia, however, devised a convincing way to show her that volume would not change as the shape of an object changed. In Alicia's mind, this constituted solid proof or evidence, and she dropped her own claims regarding the issue. The exchange illustrates that at least a few other students had also adopted the view that engaging in discourse around scientific ideas required members of the conversation to find convincing ways to promote their ideas. Alex's comments during his interview reflected this same expectation:

Interviewer: What does a good scientist have to do, or what is a good scientist like?

Alex: Um, I think, uh, they should, if they have a theory, they, they have something that they could back it up. Like to prove it.

The process of interacting with peers through the cultural tools in this science unit allowed both Alicia and Alex to develop proficiency in persuading others in a way that is germane to scientific inquiry. The teacher's guidance in helping students to frame appropriate questions and provide disciplinarily adequate explanations also supported them in this process (see previous example of Mrs. Garrett's interaction with Tyson). Being able to prove their point involved gradually learning what kinds of evidence would count as good proof for this particular audience.

With the tool of audience roles and the supporting tool of the questions chart in place during presentations, audience members were encouraged to question the methods and theories of the presenting group. The use of this participant structure made it possible to retain a balance in the relationship of power between any person's or group's ideas. It was clear in observing the classroom that the discourse during whole-group conversations did not follow the traditional patterns of student–teacher interaction and that students were taking on roles as questioners in the creation of meaning. To confirm these impressions, we sam-

pled five 10-min video clips from group presentations and tallied each student's or teacher's speaking turn under the categories "questions," "warrants/claims," and "other" (see Table 1).

Our tallies confirm our initial impressions that atypical participant structures and relationships of power were at play in the classroom. Students in Mrs. Garrett's class asked nearly three times as many questions of their fellow students as the teacher and researchers combined, and they made over 20 times more warrants or knowledge claims than the teacher. The teacher's role in the classroom as a facilitator of these intellectual conversations shows up in the other category in which students and the teacher/researcher made about equal numbers of facilitating-like comments.

Our claim that our focal students spent much of their time trying to persuade their classmates is also reflected in Table 1. Alicia and Alex's classmates asked a higher percentage of questions (60% of total), whereas the contributions of these two students fell more often under the category of warrants/claims (40% of total between the two). This preliminary measure confirms our general observations that Alicia and Alex were repeatedly questioned about their claims, and they tried repeatedly to support those claims. For Alicia and Alex, being unable to back up their theories with proof that their classmates found believable sent the students back through the formulations of their ideas, which often resulted in finding new and different ways to present their case. In this context, as reflected previously in their interview excerpts, these students found the internally persuasive word (speech that enables the listener to integrate a message into his or her own understanding) better adapted to their purposes in convincing their classmates than authoritative speech (speech that expects others to passively accept what is said).

It is important here that we take note of the fact that Alicia and Alex viewed internally persuasive discourse not only as something that worked effectively in a limited classroom context but that they both discussed these tendencies in light of the way in which scientists work and converse. In both of the previous quotations, when asked to describe what makes a good scientist, both students emphasized the importance of effective persuasion. Their emerging view of science reflects an un-

TABLE 1
Sample (Percentage) of Turns at Talk by Type for Classroom Participants

Participant	*Questions*	*Warrants/Claims*	*Other (Facilitating)*
Teacher or researcher	26	4	51
Students (all)	74	96	49
Total	100	100	100
Alicia (% of total)	5	18	13
Alex (% of total)	9	23	4

Note. The values represent percentages of the total number of turns at talk for each category of participation.

derstanding of the discipline as a body of representations that scientific communities develop and scrutinize (Burbules & Linn, 1991; Driver, Asoko, Leach, Mortimer, & Scott, 1994). Lemke (1990) confirmed that talking about scientific concepts involves "doing science through the medium of language" (p. ix) and that this language includes questioning, arguing, and discussing. Through the comments made by Alicia and Alex in their interviews, one can see that they, and a number of their peers, were engaged in the issue of sinking and floating in a disciplinary-appropriate way. These realizations, in addition to the particular concepts about sinking and floating that the students were beginning to master, constituted much of what was intended by and what was learned through the PATHS project. We discuss in the next section the ways in which Alicia and Alex gained mastery over these concepts.

Persuasive discourse, then, as an outcome of the cultural tools mentioned previously, reflects the changes in the relationships of power in the classroom in two ways. First, in the largely social realm of the classroom, the expectation for persuasive discourse among classmates limited the power of students who advocated certain theories or ideas by requiring adequate evidence to support their claims. Second, in the largely disciplinary realm of the classroom, the use of this science-like discourse positively affected the relation of power between the student and the concept. By bringing students into contact with the true work and nature of science, the "mystique of science" (as Lemke, 1990, described) is dispelled. Concepts become accessible, negotiable, and evolving entities in the students' minds. These two aspects of persuasive discourse complement each other in that they positively serve the goals of both the social world of the classroom and the disciplinary realities of the subject matter.

What Did They Learn?

Given their level of engagement in the topic of sinking and floating, we would anticipate (and hope) that Alicia and Alex did, in fact, develop deeper understandings of the subject matter than they had when starting the unit. We discuss here the intellectual progress that both students made regarding the specific subject matter and suggest how their experiences during the Sinking and Floating unit may have prepared them for future learning (Bransford & Schwartz, 1999).

Alex proved an interesting case in analyzing what he learned during the unit because he came to sixth grade with a particular experience on the topic. During his interview, Alex stated that his fifth-grade class (from a previous school) had done an experiment with pieces of clay, apparently with the purpose of demonstrating that the shape of the clay influences its sinking or floating. Throughout the unit, Alex struggled to support the claim that shape (indicating the surface area) determines the sinking or floating of an object, and only toward the end of the unit did

he begin to acknowledge others' competing theories. Materials matter was the official final theory of his group, with which he agreed.

Alex's prior experience created a somewhat disjointed learning experience for him. Because the experiments were designed to implicate density and not buoyancy, Alex had no direct way of seeing the interaction between these two factors through the materials that he was given to test. Alex's assertion that "everything matters" during his postinterview, however, was indicative of the fact that he had expanded his previous conception that only surface area plays a role. Due to Alicia's explanation to the class about the concept of density, Alex also held some basic understandings of the term density. During the interview, he described the mathematical formula, the density of water versus objects, and explained that density is how many "things" could fit into a particular size of object. Thus, although Alex still experienced some confusion during the interview about how things such as density, materials, weight, volume, and shape might fit together to explain sinking and floating more completely, he was aware that there were relations between these factors that he could test for by comparing "same shape and same weigh[t], except different materials to test the material." In this explanation, Alex also showed that he had developed an awareness of controlling variables to test one particular variable at a time.

Alicia made perhaps the greater progress in understanding the subject matter content during the unit. At the beginning of the unit, she thought, as did many of her peers, that weight alone determined the sinking and floating of objects. Alicia's group presented this theory during their first presentation, and Alicia at first attempted to explain away contradictory evidence by stating that they might have misjudged the weight of particular objects. Further pressing from the teacher and from the class led Alicia to abandon this theory and seek out other possibilities using books, encyclopedias, and computer software research tools. Although the concept of density did not become immediately clear to her, by the final day of the unit, Alicia had a refined enough understanding of density to lead the class in explaining this concept. At that point, Alicia was able to make an analogy to population density (a concept the class had briefly touched on previously). When Mrs. Garrett taped off a square on the floor, Alicia, with the assistance of another student Yoshi, called students up to stand in the square and represent what different densities would look like.

By the time her interview took place, Alicia, like Alex, had looked up the mathematical equation for density and could clearly relate how this influenced the sinking and floating of objects. During the interview, she also showed an awareness of controlling variables to compare objects along a given dimension, stating that of two objects with the "same volume," one can have a "bigger density … which will make it heavier." Thus, she was able to integrate her previous conception of weight with her current understanding of density. Alicia also integrated the theory of materials matter by stating that objects made with the same materials would have equal densities.

In addition to their understanding of the specific subject matter of sinking and floating, Alicia and Alex also made great gains in refining their epistemologies of science. In their interviews and in the classroom discourse data, both students expressed an understanding of the coordination between theories and evidence. Both talked about how disagreements were natural in science, citing their own experiences in the classroom as evidence. During her preinterview (at the beginning of the school year), Alicia's response to the question of whether or not scientists disagree with each other alluded to differences in factual information that two scientists might disagree on, for instance, "they could be disagreeing on … the height of like a planet." Following the Sinking and Floating unit, she understood disagreements in science to also include differences in the ways that evidence could be interpreted. Although we lack a preinterview from Alex, we see in his post-sinking and floating interview that he appreciated the uncertainty of science and found it "exciting" when he could find proof for his claims that others would believe.

Given the progress that Alicia and Alex made during the Sinking and Floating unit, we are confident in claiming that the ways of participating enabled by the cultural tools and participant structures within the classroom promoted deeper learning of the subject matter for these students. Giving students higher positions of power in both the social and disciplinary realms of the classroom promotes the kinds of conversations in classrooms that help students challenge and refine their previous conceptions around the subject matter. Although we take these conversations to represent positive changes in the classroom generally, we turn now in the next section to examine the extent to which affording students these higher positions of power in the classroom could potentially compromise the equally important goal of equity among students.

Was the Classroom Equitable?

We have presented a case study of two seemingly remarkable students within a particular classroom environment. Given the selectiveness of our data and the findings that we reported, our readers will naturally have concerns about the generalizability of our claims and the equitable nature of such classrooms. We too have these concerns. Questions we have mulled over ourselves include "Were Alicia and Alex intellectually privileged in some way that enabled them to dominate classroom conversations?" "Were other students disadvantaged by their level of participation?" "Would these students succeed in any classroom participant structure?" The answer that we have found to satisfy each of these questions is both yes and no. To answer the first question, Alicia and Alex were both described by their teacher as intelligent among the higher academic students in the class. In our observations of the classroom discussions, Alicia and Alex also seemed to have a greater ability to follow the arguments that others were making and were

more cogent in formulating their own claims. However, we wish to point out that these two students did not show up in all classroom conversations in the same capacity. In other units, the Spontaneous Generation history/science unit, for example, other students came to the fore in class discussions while Alicia and Alex played a larger role as audience members and questioners. Thus, the privilege or position of power that these two students seemed to have in the Sinking and Floating unit may have had more to do with their specific interests in the subject matter than with their intellectual capabilities.

To the question of whether or not other students were disadvantaged by these two students' involvement in sinking and floating, we again answer yes and no. Some students did express frustration with Alicia and Alex's bantering and were silenced when they could not follow the conversation. We see these outcomes as serious shortcomings of our classroom design and we worry about the fact that a few students did not publicly participate at all during this unit. As we look beyond the sinking and floating data, however, our preliminary findings suggest that as the year went on, more and more students did participate in classroom discussions. By the final unit on Spontaneous Generation, which occurred in May, the distribution of student participants appeared to have evened out, with different students emerging on different days to explore their ideas. What we conclude from these early findings is that although Alicia and Alex readily appropriated the participant structures and cultural tools as they were introduced into the classroom, this did not mean that other students would not have eventually done so. Establishing new relationships of power for these other students may have taken longer, but we are optimistic that with time all students would hold some stake in the social and intellectual pursuits of the classroom. That said, we do caution anyone who engages in this kind of teaching or research to be cognizant of the fact that students can come into these learning situations with an established social pecking order and that such divisions can influence students' access as participants to the conversations (Lensmire, 2000). As instructors, we must do as much as we can to empower the students who come to our classrooms with these social disadvantages. In this pursuit, we recognize Cohen's (1994) work as being particularly relevant and useful.

We have already alluded to an answer for our third question of whether or not students like Alicia and Alex would succeed given any participant structure or classroom setting. It is our opinion this is not necessarily the case. Although both students were described as strong academically by their teacher, we have evidence to support the fact that Alicia and Alex may not have participated in similar ways in other contexts. Lindsay Cornelius (2004) collected data as part of a follow-up study on students from the PATHS study and has found that for Alicia, at least (Alex did not participate in the study), her experiences in her middle school science did not at all resemble her experiences during the Sinking and Floating unit. In a more traditional participant structure, Alicia tended to be

quiet and to only participate when called on. Her seventh-grade science teacher described her as an average student. Given these findings, we feel even more confident in attributing the patterns of participation for these two students to the support offered by the classroom environment and not some notion of the students' personal backgrounds or dispositions.

DISCUSSION

The three aspects of power that we have named and described previously first define the social relationships of the focus students in this classroom setting. Having ownership of ideas shifted power from the teacher to the students; neither student mentioned their teacher as an authority on the ideas of sinking and floating but rather credited their own ideas and research. Partisanship redefined the relationship of power between these two students as they became spokespersons for different theories throughout the unit, and it allowed them to have and voice their own opinions on the issue. Persuasive discourse created a new relationship of power among the students as well, as fellow classmates and the teacher became monitors of the ideas espoused by the focus students and served to balance their power.

The three aspects of power also define the intellectual, disciplinary relations between the focus students and the concepts being studied. Ownership of ideas, in this case, closed the distance between the student and the scientific concepts, creating a feeling for the students of being creators of their own theories and a sense that they could use these ideas flexibly. Partisanship allowed them to further explore and own these ideas by presenting them as potential explanations before the class. Finally, through their own persuasive discourse in trying to convince their peers, these two students glimpsed the true nature of scientific inquiry that for their theories to be powerful, they needed to provide adequate and convincing proof for their argument. As we have stated previously, these affordances of power impacted the social and the disciplinary worlds within the same moments in the classroom by creating ways of participating that reflected the real work of scientific communities.

The participant structures in the PATHS classroom and the types of discourse that emerged within these relationships of power differ dramatically from what other researchers have observed in classroom settings. Typically, discourse in classrooms involves what Mehan (1979) and Cazden (1988) described as I–R–E sequences wherein the teacher initiates most of the questions, students respond, and the teacher evaluates student responses. Flanders (1970) similarly found that the structure in learning activities is almost always established by the teacher. More recent studies have confirmed these patterns of interaction within more traditional classroom participant structures (Herrenkohl & Guerra, 1998; Lemke, 1990).

Implementing new participant structures in science classrooms, however, does not ensure that disciplinary-specific discourses will actually occur. Some studies that have made use of new participant structures (e.g., small groups) in science classrooms have reported findings that reflected some social transformations of power but that failed to elicit new relations of power to the science content through appropriate disciplinary engagement. Bianchini (1997), for example, reported on another sixth-grade classroom that worked in small groups around scientific ideas and then presented their ideas to the class. The main cultural tools introduced into this classroom were adopted from Cohen's (1994) Complex Instruction Model and included the following aspects: (a) group tasks, (b) classroom management (including procedural roles), and (c) treatment of status problems. Thus, the thrust of this research was to address social inequities in the classroom. Not surprisingly, Bianchini reported that disciplinary-specific student engagement around scientific ideas was "simply rare and often short-lived" (p. 1052). Students in this classroom were more involved in conversations around group processes and products.

Shepardson (1996) found a similar situation in a study of first graders. Students in one classroom were given the cultural tools of small groups and "science journals" to engage them in discussions around the life cycles of insects. As was found in Bianchini's (1997) study, these students were also more likely to engage in conversations that involved "negotiating action" rather than "negotiating meaning." Disciplinary ways of talking about scientific ideas seldom occurred.

What we learn by contrasting these two studies with our study is that not all cultural tools and participant structures are as effective in transforming the relationships of power among students and between students and concepts. In the two studies we have just described, the scientific concepts remained seemingly remote to the students, as the cultural tools did not give them a chance to create and own ideas around the subject matter. With less personal investment in an idea, these students felt less inclined to discuss or defend aspects of the subject matter in their peer groups. A review of these articles finds that putting students in small groups, having class presentations, or promoting only the social goals in the classroom did not guarantee that deep discussions around scientific ideas would occur.

We propose three reasons for why the cultural tools used in the PATHS sixth-grade classroom found greater success in encouraging discussion around scientific ideas and theories. First, the process of thinking like a scientist was highly scaffolded for students. Through the use of audience roles and questions charts, students had to do less guesswork in figuring out what kinds of statements and questions make for better scientific conversations. Likewise, the process for creating their own theories was clearly laid out in the structure of the SenseMaker board. These cultural tools gave students important information on how to talk about theories and what the status of a theory truly is in an ongoing scientific conversation. Second, as stated repeatedly throughout this article, the new relationships of power in the classroom (both social and disciplinary) created opportuni-

ties and even motivation for students to explore scientific concepts in depth. Ownership of an idea and the desire to persuade each other led Alex and Alicia into deeper and deeper conversations around the ideas contained in the problem of sinking and floating. Their new relationships of power in their environment allowed these two students to engage in the discipline of science as a scientist would do. Last, the teacher played a large role in shaping the students' participation throughout the unit. Cultural tools, in and of themselves, do not convey the value of deeply engaging in scientific inquiry. Mrs. Garrett aided the students in thinking about sinking and floating by giving these tools shape and meaning. By respecting each student's current attempts at understanding and promoting confusion as a starting point, she gave the students the support they needed to work through these very difficult ideas.

The enduring power of these two students' experiences with sinking and floating was nicely illustrated in a conversation with Alicia nearly a year after she and Alex had their big debate. Alicia began talking about Alex again during this interview that took place within the study that followed a few of Mrs. Garrett's students as they made the transition to middle school:

Alicia: Let's see, he [Alex] said it yesterday. He, we, we were talking and he brought up the subject, we were talking in Health …
Interviewer: Mm-hmm.
Alicia: … he brought up the subject of last year and how we always debated and stuff. And he's like, "Yeah, but I was always right." And I was like, "No you weren't!" And so we got into this big discussion about who was right. [laughs] And so, and so we-
Interviewer: About which thing, about the Sinking and Floating?
Alicia: Yeah, so we started talking about the density thing …
Interviewer: Oh, uh-huh.
Alicia: … and then the Rosa Parks thing.
Interviewer: Uh-huh.
Alicia: And, um, Mr. Harvey was like, "Why don't you two finish this after school?" [laughs] "This has nothing to do with Health." And we're like, "But I'm right!"

For Alicia and Alex, the importance of what they learned during a sixth-grade science unit and their relationship to one another throughout the process of learning continued to hold significance for both of these students. For our purposes as researchers, Alicia's remarks reaffirmed the practical significance of considering both the disciplinary and social worlds of the classroom when talking about and evaluating classroom participant structures. Designing participant structures that encourage meaningful engagement with a concept in a discipline while also encouraging meaningfully conversations with classmates allows these

students the opportunity to share and continue sharing their interests and ideas with each other.

CONCLUSION

Looking at classroom interactions through the lens of power is not an idea that is new to educational research. What we in this study did that differs from previous research, however, was to analyze power not only in terms of the social relationships that exist in classrooms but also in terms of the disciplinary relationships, and we did these two analyses in tandem. In this research study, we have shown how looking at classroom participant structures and cultural tools through the lens of power can provide new insights into the strengths and weaknesses of these structures. The goal of this discussion of power in the classroom was not to imply that teachers should relinquish their responsibilities as guides in the learning process. In this article, we have simply tried to show that for students to engage with and pursue learning in a disciplinary specific way, they must first possess their own motives and ideas. To craft participant structures that respond to students' educational as well as personal and social needs, consideration of the interactions of multiple relationships of power in the classroom must be made. In this study, we used interview data from two students to explicate the ways in which power was transformed in this particular environment. There are both strengths and limitations with using only two students as the focus of this kind of analysis. The strength of such an analysis is that we can get a sense of how broadly one child can be affected by the tools and structures with which she works. This strength, however, also proves a weakness in that the social and disciplinary outcomes for these two students are limited in their generalizability to other students and settings.

Although this study gives one a glimpse into the potential that exists in the transformation of power in the classroom, further studies must account for how different types of student learners come to accept the affordances of power made available to them by the environment, if at all. Lindsay Cornelius's ongoing work involves delving into this very issue. Using the same classroom as described in this study, she is currently attempting to identify different patterns of participation across one history and one science unit. Questions of who participates, during which participant structures, and in what ways, are currently being explored. These issues are closely linked with those that motivation researchers have typically explored involving questions of how to engage students in their own learning and why certain students seem to be able to do this more easily than others. Whereas motivation research typically has focused more on psychological aspects of the learner, we believe that bringing a sociocultural lens to bear on these issues will expand the ways of explaining why engagement in learning does or does not happen. This perspective includes looking at the ways in which allowing students

opportunities for legitimate participation (Lave & Wenger, 1991) in communities of practice and discourse can cultivate the identities and interests of students and thus provide students with personal reasons for engaging in school. Researching motivation has much to offer in terms of thinking about complex learning environments, and we believe that more productive research is needed in integrating the disciplinary concerns with those of participation and motivation.

Another related direction of research that we foresee coming out of this study involves understanding the forms of collaboration that are present in classrooms that afford this type of participation. With a transformation in the relationships of power in the classroom comes opportunities not only for teachers to interact in new ways with their students but for students to interact with each other in the absence of the teacher. There is much we still do not know about how collaboration during whole-class discussions connects up with smaller group experiences in which the teacher may not always be immediately present.

In this study, we provided an example of how a new analytic lens, looking at classroom learning through the relationships of power it allows, can create the potential for accounting for multiple interactions in complex learning environments.

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REFERENCES

Au, K. H. P., & Mason, J. M. (1981). Social organization factors in learning to read: The balance of rights hypothesis. *Reading Research Quarterly, 17,* 115–151.

Bahktin, M. M. (1981). Discourse in the novel (C. Emerson & M. Holquist, Trans.). In M. Holquist (Ed.), *The dialogic imagination* (pp. 342–354). Austin: University of Texas Press.

Bell, P. (1997). Using argument representation to make thinking visible for individuals and groups. In R. Hall, N. Miyake, & N. Enyedy (Eds.), *Proceediings of CSCL '97: The Second International Con-*

ference on Computer Support for Collaborative Learning (pp. 10–19). Toronto, Ontario, Canada: University of Toronto Press.

Bell, P. (2004). Promoting students' argument construction and collaborative debate in the science classroom. In M. C. Linn, E. A. Davis, & P. Bell (Eds.), *Internet environments for science education* (pp. 115–143). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Bell, P., & Linn, M. C. (2000). Scientific arguments as learning artifacts: Designing for learning from the web with KIE. *International Journal of Science Education, 22*(8), 797–817.

Bianchini, J. A. (1997). Where knowledge construction, equity, and context intersect: Student learning of science in small groups. *Journal of Research in Science Teaching, 34,* 1039–1065.

Bransford, J. D., & Schwartz, D. (1999). Rethinking transfer: A simple proposal with multiple implications. In A. Iran-Nejad & P. D. Pearson (Eds.), *Review of research in education* (Vol. 24, pp. 61–100). Washington, DC: American Educational Research Association.

Bruner, J. (1960). *The process of education.* Cambridge, MA: Harvard University Press.

Burbules, N. C., & Linn, M. C. (1991). Science education and philosophy of science: Congruence or contradiction? *International Journal of Science Education, 13,* 227–241.

Cazden, C. B. (1988). *Classroom discourse.* Portsmouth, NH: Heinemann.

Cohen, E. G. (1994). *Designing groupwork: Strategies for the heterogeneous classroom* (2nd ed.). New York: Teachers College Press.

Cornelius, L. L. (2004). Learning to participate in disciplinary discourses: What happens when the conversation ends? In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. Scott Nixon , & F. Herrera (Eds.), *Embracing diversity in the learning sciences: Proceedings of the Sixth International Conference of the Learning Sciences* (pp. 136–141). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher, 23*(7), 5–12.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in the classrooms. *Science Education, 84,* 223–238.

Engle, R. A., & Conant, F. R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction, 20,* 399–484.

Erickson, F. (1982). Classroom discourse as improvisation. In L. C. Wilkinson (Ed.), *Communication in the classroom* (pp. 153–181). New York: Academic.

Flanders, N. A. (1970). *Analyzing teaching behavior.* Reading, MA: Addison-Wesley.

Foucault, M. (1999). Power as knowledge. In C. Lemert (Ed.), *Social theory: The multicultural and classic readings* (pp. 475–478). Boulder, CO: Westview.

Goffman, E. (1974). *Frame analysis.* Cambridge, MA: Harvard University Press.

Goodnow, J. (1990). The socialization of cognition: What's involved? In J. W. Stigler, R. A. Shweder, & G. Herdt (Eds.), *Cultural psychology: Essays on comparative human development* (pp. 259–286). New York: Cambridge University Press.

Goodwin, M. H. (1990). *He-said, she-said: Talk as social organization among black children.* Bloomington: Indiana University Press.

Hatano, G., & Inagaki, K. (1991). Sharing cognition through collective comprehension activity. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 331–348). Washington, DC: American Psychological Association.

Herrenkohl, L. R., & Guerra, M. R. (1998). Participant structures, scientific discourse and student engagement in fourth grade. *Cognition and Instruction, 16,* 431–473.

Herrenkohl, L. R., Palincsar, A. S., DeWater, L. S., & Kawasaki, K. (1999). Developing scientific communities in classrooms: A sociocognitive approach. *The Journal of the Learning Sciences, 8,* 451–493.

Lampert, M. (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal, 27,* 29–63.

Lave, J., & Wenger, E. W. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge, England: Cambridge University Press.

Lemke, J. (1990). *Talking science: Language, learning, and values.* Norwood, NJ: Ablex.

Lensmire, T. (2000). *Powerful writing, responsible teaching.* New York: Teachers College Press.

Mehan, H. (1979). *Learning lessons: Social organization in the classroom.* Cambridge, MA: Harvard University Press.

O'Connor, M. C. (2001). "Can any fraction be turned into a decimal?" A case study of a mathematical group discussion. *Educational Studies in Mathematics, 46,* 143–185.

O'Connor, M. C., & Michaels, S. (1996). Shifting participant frameworks: Orchestrating thinking practices in group discussion. In D. Hicks (Ed.), *Discourse, learning, and schooling* (pp. 63–103). New York: Cambridge University Press.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and comprehension monitoring activities. *Cognition and Instruction, 1,* 117–175.

Phillips, S. (1972). Participant structures and communicative competence: Warm Springs children in community and classroom. In C. B. Cazden, V. P. John, & D. Hymes (Eds.), *Functions of language in the classroom* (pp. 370–394). New York: Teachers College Press.

Polman, J. L., & Pea, R. D. (2001). Transformative communication as a cultural tool for guiding inquiry science. *Science Education, 85,* 223–238.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* New York: Oxford University Press.

Sharrock, W. W. (1974). On owning knowledge. In R. Turner (Ed.), *Ethnomethodology* (pp. 45–53). Middlesex, England: Penguin Education.

Shepardson, D. P. (1996). Social interactions and the mediation of science learning in two small groups of first-graders. *Journal of Research in Science Teaching, 33,* 159–178.

Shulman, L. S., & Quinlan, K. M. (1996). The comparative psychology of school subjects. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 399–422). New York: Simon & Schuster.

Stevens, R., Wineburg, S., Herrenkohl, L., & Bell, P. (under review). *The comparative understanding of school subjects: Past, present, and future.*

Tabak, I., & Baumgartner, E. (2004). Do you know the way to inquiry-based learning?: Revealing elusive issues in the teacher-as-guide model. *Cognition and Instruction, 4,* 393–429.

Wertsch, J. V. (1991). *Voices of the mind.* Cambridge, MA: Harvard University Press.

Wertsch, J. V. (1998). *Mind as action.* New York: Oxford University Press.