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Facilitating Identity Formation, Group Membership, and Learning in Science Classrooms:

What Can Be Learned From Out-of-Field Teaching in an Urban School?

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Abstract

This paper explores both the obstacles and the possibilities for students developing identities associated with science by engaging in solidarity-building classroom interactions. Data come from ethnographic research conducted in a diverse eighth-grade urban magnet school classroom in which the teacher taught out of field for part of the year. Contrary to expectations, more students participated and reported enjoying science when the teacher was out of field. Analysis of classroom interactions indicated that while in field, the teacher primarily engaged in “front stage” performances that hid her struggles with the material and accentuated students’ views of science as an elite status group. The types of solidarity that developed among students often did not involve science language and sometimes involved students rejecting peers’ claims to membership. However, when out of field, the teacher allowed students into her “backstage,” where her struggles and learning processes were more explicit. These practices lessened the social distance between teacher and students, and reduced the risks of using science language, thereby encouraging solidarity and group membership. This study provides insights into some of the ways that teachers, particularly those in urban settings characterized by diversity, might be more successful at facilitating identity formation and learning in science.
Introduction

Science is taught to all students in the United States, but many students leave school without developing an interest in the subject and without the skills and knowledge to either go on to further study or critically assess science-related issues relevant to their lives. Particularly troubling are inequalities in outcomes, as demonstrated by disparities between White and minority students and students from different socioeconomic backgrounds in both science achievement (Rodriguez, 1997) and the percentage of people seeking science-related careers (Kahle & Meece 1994). Several researchers have described how problems with science education in low-income, predominantly minority schools, extend beyond the lack of material resources to schools’ inability to facilitate all students’ developing identities and feelings of group membership associated with science, which they have argued is necessary for achievement. Findings include that low-income, minority, and female students may not develop a sense of efficacy and identity associated with science when science is portrayed as objective, distant, overly difficult, and accessible to only a few (Barton & Yang, 2000; Lemke, 1990); when language and methods of argumentation favor middle-class, White, and male students (Lemke, 1990); when students’ cultural capital is not valued (Elmesky, 2001; Seiler, 2002; Tobin, Seiler, & Walls, 1999); and when Black female students’ gendered identities do not correspond with the “silent girl’s” gendered identities valued in schools (Brickhouse, Lowery, & Schultz, 2000; Fordham, 1996).

The privileging of some students’ dispositions and identities in science classes and the portrayal of science in elitist ways may seem like difficult issues with which to contend, but they
do not completely determine student outcomes. Students do not decide whether they identify with science in some abstract sense based on these categories, as demonstrated by the reality that many students from backgrounds that are not privileged still do develop identities associated with school science. Rather, identities are works in progress (Lave & Wenger 1991) and are the products of ongoing interactions (e.g., Reveles, Cordova, & Kelly, 2004; Roth et al., 2004), suggesting the need for studies that focus on the types of classroom interactions that foster identification with school science and those that interfere with it among groups of students who have traditionally faced exclusion. This paper draws on theories of social interaction to explore both the obstacles and the possibilities for students developing identities associated with science through an analysis of ethnographic data from an eighth-grade classroom in a racially, ethnically, and socioeconomically diverse urban magnet school. The research questions for this study included the following:

1. Which classroom conditions and teacher practices contributed to the generation of positive interactions surrounding science, characterized by a common mood, solidarity among participants, a sense of identity and group membership, and sustained interest in the subject?

2. What patterns existed among these conditions and practices that can be applied to thinking about how other teachers could encourage group membership surrounding science within their own classrooms?

3. What is the relationship between categorical identities, such as race, class, and gender, and school science identities on the level of everyday interactions?
While these were guiding research questions, related questions continued to emerge throughout the study based on findings and on the interests of the student and teacher participants. One issue that became particularly salient as the school year progressed was the relationship between the level of the teacher’s expertise and that of students’ participation, interest, and sense of group membership in science. Specifically, both the teacher (Ms. Loman) and I became interested in the counterintuitive initial finding that many of the students participated more frequently and reported enjoying science more when Ms. Loman was teaching chemistry, a topic that was outside of her main field of expertise, than when she was teaching physics, which is her main field.

A concern with out-of-field teaching is that such teachers may not have the content knowledge and the pedagogical content knowledge (Shulman, 1986) to effectively facilitate student learning (Ingersoll, 1999). Predictably, Ms. Loman experienced some difficulties while teaching chemistry, as by her own and by her students’ reporting she was less organized, was not able to answer all of the students’ questions, was often ineffective at generating spontaneous examples to illustrate concepts, and had to rely on books and handouts when conducting her lessons. While it seems likely that Ms. Loman’s lack of subject knowledge would have made students less motivated to achieve, surprisingly interviews with students showed that many enjoyed chemistry more than physics, and observations of classroom interactions indicated that a greater number and variety of students voluntarily participated in chemistry. In addition, some of the students who avoided using science language during the physics unit seemed more willing to do so during the chemistry unit.

In describing these students’ preferences for chemistry, I do not intend to suggest that teachers should teach out of their fields. Rather, I found that comparing Ms. Loman’s in and out-
of-field teaching practices was helpful in addressing the larger questions of the study regarding classroom interactions, group membership, and identity. Focusing on out-of-field teaching provided insights into some of the approaches that might be helpful for teachers striving to facilitate student interest and achievement in science, particularly in urban settings characterized by high levels of diversity.

In this paper, I argue that what differed between the two subjects was how easy it was for students to view a science-centered community as accessible to them. I discuss how in chemistry Ms. Loman was more successful in encouraging students to develop feelings of group membership associated with science. While they had less access to her subject content expertise, they had more access to seeing how their teachers engaged in a socially situated learning process. The increased student participation and comfort level in the classroom were influenced by changes in the perceived social distance among themselves, the teacher, and the subject matter.

Those who are knowledgeable in science can be thought of as belonging to a status group, similar to Weber’s (1922) conception, in which members are marked by taste, language use, and culture. For science teaching to be effective, it can be argued that teachers need to be able to facilitate students’ entry into a type of a status group centered on the practice of science. While status groups can be seen in a positive light as providing opportunities for new forms of membership, the view of science as such a group can be problematic in a classroom. Science can be experienced as exclusive if the associated group is not perceived as being open to new members, if classroom environments do not afford students’ agency in acquiring the relevant attributes for membership, or if students experience negative emotions when encountering this group and the associated language and culture.
Lave and Wenger (1991) describe learning as a process by which people acquire the skills, knowledge, and language for participation in communities that they wish to join. Feelings of group membership are essential for learning, as people must desire to be a part of such a community and expect that the group will accept them to have the incentive to develop these skills. Learning science in particular requires active social participation within group activity, as it is a discursive practice, requiring shared use of language to develop and discuss thematic patterns or concepts (Lemke, 1990). A teacher’s role, therefore, needs to extend beyond transmitting science content to establishing classroom conditions that are conducive to students’ developing a sense of membership.

Durkheim (1912/1965) describes how the sacred symbols used in rituals can generate solidarity and serve to unify groups. In a science-related status group, the language of science could potentially serve as a unifying force, allowing members to recognize each other. Some researchers in science education have described the importance of language use in academic identity formation (e.g., Brown, 2004; Reveles et al., 2004), which is related to students’ sense of membership in a scientific community. In this paper, I describe how in Ms. Loman’s physics classroom, science language often did not serve as a symbol to focus solidarity-generating rituals, partially because of the considerable social distance between the teacher and the students with regard to science.

In class activities, the teacher primarily engaged with the students in front-stage performances (Goffman, 1959), which hid her own struggles with the material. Interviews with students suggest that they perceived her knowledge of science as indicative of membership in an elite group that was inaccessible to them. The types of solidarity that developed in the classroom often were either not focused on science or a result of “backstage” performances (Goffman,
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1959) between students. In these performances, students would not use much science language and ridicule others who did, particularly targeting students whose categorical identities and prior achievement suggested to them that they were unlikely candidates for membership in a group centered on science. Use of science language, which would imply a claim to membership, was not seen by some students as a route to solidarity with the teacher or other students but was perceived as risking shame, which Goffman (1967) describes as occurring when a person’s claims for a particular “face” are not accepted.

When Ms. Loman was out of her field as she taught chemistry, her practices and language use changed how some of the students viewed their own potential for entering into a science-related status group. Rather than only putting on a “front stage” teacher performance, Ms. Loman allowed the students into the backstage, letting them see how she struggled with the material and was willing to ask others for assistance. These practices reduced the social distance between the teacher and the students and seemed to also reduce the social risks for students using science language. Rather than being associated with negative experiences for some of the students, science language and the related content could serve as symbols allowing for solidarity that encompassed the entire class.

**Status and Identity**

What kind of group is science? While science can be considered an array of subject matter and skills, or in a more critical view of learning, a form of cultural capital (e.g., Bourdieu, 1986), learning any particular subject does not just involve the acquisition of knowledge, but can be thought of as the moving into and the marking of one as a member of a particular social
Weber (1922) conceptualized a status group as determined by such factors as education, behavior, taste, how one makes money, culture, lifestyle, and a recognized social identity. While status may not be equivalent to material wealth, status groups are associated with social hierarchies and can serve as a basis for inequality in society, as some groups are considered high status and maintain social distance from those who are considered low status.

While research scientists are a particular professional group in our society and correspond somewhat to an economic class, knowledge of science can also serve as an indicator of membership in an elite status group, as it is associated with intelligence and with being able to do something that not everyone can do (Lemke, 1990). One attribute of a status group is that members can recognize each other. Those who are knowledgeable in science can be distinguished by a particular type of vocabulary, the ability to use it correctly, and the use of particular methods of argumentation.

Within the profession of teachers, science teachers are sometimes accorded a higher status, defining themselves as professionals by the subject matter that they teach (e.g., Helms, 1998). In colleges, science majors are accorded a higher status than many other majors, and introductory biology courses are termed “weed-out” courses (Barton, 1998). Teachers reinforce this status of their profession by portraying the subject to their students as one that only special people can understand (Barton & Yang, 2000; Lemke, 1990). Ms. Loman describes her own decision to pursue science in a way that suggests that she attributes high status to the subject: “I felt good in college, that I could understand physics, since physics is such a hard subject. Also I was one of very few women who majored in it, so you kind of feel special because of that.”

Some students may be glad that science has elitist connotations, as it can be a source of pride to understand it while others do not. There is a value in belonging to a status group that is
hard to join, and science teachers may in some ways be in a paradoxical situation, as they have
been set apart for their ability in science yet their job is to help all students learn science well.
Among the students in this school, “I am not good at science” (also “I am not good at math”) is
heard frequently. When the same students talk about low history grades, they say “history is
boring” or “I don’t study,” but I have not heard any student say “I am not good at history.” While
this may seem to be a trivial difference, it shows that “science participant” may be considered
more of a recognized high-status social identity than a participant in other types of content. It is
also important to note that there are some negative associations among students associated with
science, such as “nerd.” However, overall the students still consider science a hard subject and
that those who know it are smart. One of the student researchers, Aileen, describes how
knowledge of science is what leads to the difference in the respect that her parents are accorded
as medical assistants. They make $6.50 an hour, while doctors make significantly more. For her,
knowledge of science is tied to both economic class and status differences.

Why is the view of science as a high-status group problematic for teaching and learning?
The national science standards advocate “science for all” as a goal for American public schools
(National Research Council, 1996), suggesting that all students can and will learn science.
However, if knowledge of science is seen as an indicator of membership in a status group that is
not easy for people to join, and if there is considerable social distance between teachers who
have successfully joined this status group and their students, students may be discouraged from
pursuing science as a valued identity and may fear talking science.

The perception of science as a high-status group may be alienating for all students, as
they are still youth and are unlikely to have acquired membership in such a group. However,
continual experiences of unsuccessful interactions can have a particularly negative effect on
Although aspects of students’ identities are influential, categories such as race and gender do not completely determine whether or not a student will develop a sense of membership in science. There is room for personal agency and therefore undetermined outcomes if one takes a view of identities and selves as different from each other. Wiley (1994) develops an idea of the structure of the self, on the basis of the work of Peirce and Mead, that involves an internalized conversation between the I, me, and you, as well as temporary and permanent visitors and the unconscious. He writes that identities should not be equated with these selves, as identities “hang on” the structure of the self, and may be more or less salient depending on the situation.

Wiley describes how people do not act based only on their identities, but instead based on a drive for intrasubjective ritual and solidarity. He writes, “The internal conversation can create intra-personal rituals that, in turn, produce and maintain the internal solidarity” (p. 109). In his discussion, he describes how self-feelings involve social reflexivity, in that our thoughts are influenced by our taking the attitudes of others toward ourselves. While taking the attitudes of others may primarily involve issues such as moral obligations, these attitudes may also include stereotypes, media images, circulating ideas about how various identities may affect potential membership in science, and experiences of being treated in particular ways on the basis of race or gender. Wiley describes how depressed people may get into a cycle of negative thoughts that prevent internal solidarity. It is possible that discouraging voices of “visitors” may influence
whether a student experiences internal solidarity while interacting in science class. A lack of internal solidarity over time could restrain participation.

**Social Distance and Solidarity**

Goffman’s (1959) conception of how people engage in front-stage and backstage performances in workplaces can be applied to understanding how social distance between teachers and students relating to science is maintained. He describes how workers keep the preparation aspects of their work hidden, in the backstage, in order to keep their frontstage performance for the audience as professional-seeming, and at times awe-inspiring, as possible. Goffman writes, “Often the real secret behind the mystery is that there is no mystery. The real problem is to prevent the audience from learning this too” (p. 70). Ms. Loman describes how there is pressure on her to appear as if she knows everything about the subject matter, or she will lose the students’ respect. She, like many other teachers, relies on IRE (Initiation–Response–Evaluation) dialogue (Lemke, 1990), which puts control of the conversation in her hands and reduces the possibility of her encountering a weak point in her grasp of the material. Admitting one does not know could cause a crack in an otherwise believable performance of the teacher as the complete authority. The backstage part of her job, reading up on the material, preparing lessons, and struggling with the material as a former student, is rarely if ever seen by the students while she teaches physics.

Goffman also describes how workers act as teams, in order to maintain their image for audiences, and that team members will encounter problems with colleagues if they do not uphold this image. Similarly, there is pressure on teachers as a whole to maintain social distance from
their students in order to support other teachers’ and administrators’ doing so. Teachers may not intend to reinforce social distance or portray science as overly difficult. Ms. Loman describes how she wants all of her students to do well in science and “see that science is not so hard.” However, these intentions exist alongside other interests and habits. Science is a subject that is surrounded by mystique (Lemke, 1990) and could lose its high status if it was not thought of with some awe.

Alongside teachers’ drive to maintain authority and awe is also a drive for solidarity among classroom participants. Durkheim (1912/1965) describes how solidarity is achieved through rituals that focus on sacred objects, unify the group, and serve to uphold the values and the coherence of society. Collins (2004) builds on this, describing how Durkheim’s ideas are useful for understanding not only solidarity within whole societies but also the formation of groups on a more micro level. He describes how people seek successful interaction rituals (IRs) in their everyday interactions, characterized by mutual focus, rhythmic entrainment with others, and the investment of the symbols used in these rituals with emotional energy (EE). As people desire solidarity with others and the resulting high levels of EE, they will seek out further experiences that draw on such symbols. Over time, experiences of successful and unsuccessful IRs form the basis of people’s choices of which groups to join and which identities to acquire.

Social interactions in science classes may contribute to a sense of group membership and solidarity with others present, or may instead lead to a lack of solidarity. There are various routes through which participants can seek solidarity-building IRs and, consequently, EE. Teachers can obtain solidarity with other teachers, such as when sitting in the teacher lounge discussing “problem” students. They can also gain EE in interactions with students through “order-giving”
rituals. Collins (2004) describes how every interaction produces both status membership and power effects. He describes how a successful IR in situations of somewhat equal power, such as among colleagues, hobbyists, or a religious congregation, can result in collective effervescence for most people who are present and in the solidifying of a status group. However, some IRs are better characterized as “order-giving” rituals, and may result in a gain in EE for the order giver and a loss for the order taker, without actually increasing feelings of group membership. It is possible that interactions surrounding science learning can be experienced by participants in some ways as order giving rituals, with the teacher enforcing a particular way of looking at the world on students and students losing EE in these interactions.

If the symbols from science are associated with a loss in EE for students, they may seek solidarity and EE elsewhere, for instance in the creation of their own solidarity-producing interactions within the science classroom. Goffman (1959) describes how subordinates may engage in “backstage” performances that include ridiculing the person giving orders. While students are not subordinates in the same sense as workers, students may still engage in such backstage performances as ridiculing the teacher, the subject, or each other. They may also seek solidarity by engaging in side conversations surrounding other symbols, such as television shows, which may be marginally related to the topic that is being taught. Conversely, it is possible that classroom interactions can be perceived by participants as opportunities for legitimate peripheral participation in a status group in which they are or can be members, which would lead to a gain in EE for all who are present.
Setting

City Magnet is a secondary school that includes a middle school for Grades 5–8 and a high school for Grades 9–12, both of which are housed in the same building. The eighth grade classroom that is the focus of this study had 33 students. Of these, approximately 40% were White, 34% were Black, 10% were Asian American, 10% were Latino, and 6% were multiracial. Some of these students came to City Magnet from private schools, some from elementary schools in middle-class neighborhoods, and some from elementary schools in low-income, predominantly African American neighborhoods. While all of the students were high performing in their elementary schools, at City Magnet there were large variations in academic performance that tended to correspond with whether they attended elementary school in a high-poverty area of the city.

Not only was there variation in performance on tests and quizzes among the students, but there was also considerable variation in students’ class participation, such as how frequently students volunteered answers, asked the teacher and each other questions, and engaged in discussions using science discourse. However, rather than certain students consistently participating more than others, participation varied depending on the activity, the topic being discussed, whether Ms. Loman was in or out of field, and other classroom conditions. Given the importance of engaging with science discourse for acquiring identities associated with science, investigating the classroom conditions and teacher practices that influenced this variation was an important part of this study.

The eighth-grade science curriculum as a whole is divided into trimesters of physics, chemistry, and earth science, in that order, for this particular section of the eighth grade. Ms.
Loman is a certified high school physics teacher who has taken only one semester of chemistry and has little background in earth science. She was therefore out of her main field in both chemistry and earth science. While she was not as out of field as, for example, a history teacher teaching chemistry, she still lacked considerable content knowledge in the subject that affected her ability to answer student questions, generate spontaneous examples, and anticipate misconceptions.

Methods

The research approach for this study is framed by the work of Guba and Lincoln (1989), who developed criteria for authenticity in ethnographic research that include an orientation toward helping participants work toward positive change in local settings and increasing their understandings of each other’s perspectives. To implement a more participatory research process in the interest of positive classroom change, this study was conducted in a team composed of myself, who was the university-researcher and author of this paper, the teacher researcher (Ms. Loman), and four student researchers (Ashley, Aileen, Monique, and Lisa).¹ Ms. Loman and I are White; Ashley, Aileen, and Monique are African American; and Lisa’s mother is African American and her father is White.

During the 2001–02 school year, I acted as a participant observer in the classroom, videotaping classes, taking field notes, leading biweekly research meetings, having informal conversations with students, sometimes coteaching, and leading a weekly science review session.

¹ Names of students have been changed.
I attended class two to three times each week. Data were collected in the form of field notes, student work, interviews, and video- and audiotapes of classes.

As a research team, we employed cogenerative dialogues (Roth & Tobin, 2004) in which we informally discussed issues that were of concern to both the students and the teacher, reviewed videotapes of class, and identified and examined salient incidents involving teaching and learning. I held somewhat of a facilitator role during these meetings. While all members of the research team raised issues and questions, I began most meetings with topics and video clips that could serve as initial foci for discussion. These topics were most often prepared either in collaboration with Ms. Loman or on the basis of conversations with the student researchers. During the dialogues, I sometimes posed questions and invited participants to clarify their statements to ensure that participants understood each other’s ideas and that conflicting opinions on various issues were discussed rather than de-emphasized in favor of consensus. Student and teacher researcher roles extended beyond member checking, because in these meetings the participants had the role of constructing rather than merely consenting to research questions and assertions.

During these meetings, the students did not just talk about learning science, but spoke about many other issues such as their relationships with peers, their thoughts on their other classes and the school in general, the competitive process in choosing a high school, and school rules. The variety in topics discussed helped the teacher and me to see how students situated the activity of learning science within the context of other activities, enriching our understandings of student identity formation in relation to science. The meetings also provided a setting that allowed students to interact with each other around issues of science. A limitation is that only
these four students participated in the dialogues whereas there were other classroom participants who were not heard in this format.

While in the beginning the conversations took place around participants’ emic constructions, over time etic constructions became a part of the discussions as well. The intention of the study was that by having all research participants learn and apply aspects of social theories, the voices of the adult researchers would be less privileged than would otherwise be the case. The students had the opportunity to be critical of the theoretical lenses, apply them in creative ways, and dispute the adult researchers’ interpretations. While Ms. Loman and I recognized that the students’ understandings of the theory would differ substantially because of their age and experience, the students still were able to interpret ideas on the basis of their own experiences and apply them to their own analysis of classroom events.

In addition to taking part in research meetings, the student researchers interviewed other students about science learning and high school selection. Having students interview other students was advantageous in that the students could better understand the experiences of other students, and would be able to elicit ideas and understand dialect in ways that the university-researcher could not. The students received training in conducting interviews by me, and they benefited from developing new skills and taking a more active role in constructing and carrying out the research.

Data Analysis
Studying the ways in which students demonstrate and/or develop identities associated with science is not a straightforward task, as identities are constructed through ongoing interaction and therefore studying them requires involvement with participants over time.

Furthermore, identity entails a variety of components such as group affiliations, self perceptions, presentations of self to others, and how one is received by others, which are all hard to measure. Therefore, I used a variety of forms of evidence and methods of analysis. While most students may not say directly that they identify with school science if they are asked, it may not be perceived as “cool” to do so, their participation in science class activities, their use of science discourse, and how they position themselves and others in relation to science through talk can serve as indicators of their identity as science learners (e.g., Brickhouse, Lowery, & Schultz, 2000; Brown, 2004).

Wenger (2000) describes how knowing is a form of identity, as people tend to appear to know something if it accords with how they view themselves and want others to view them. In the analysis, I examined how and when students demonstrated knowing science through participating in activities and experiments, problem solving, teaching others about science, use of science language and argumentation, asking and answering questions, and discussing science content with peers. Other indicators included students’ written work, discussions in research meetings and science lunch sessions, the teacher’s assessment, and self-reporting. I have also compared the participation of students of different educational backgrounds, prior achievement, gender, and race. As students’ identities in science extend beyond school, it was important to also gain insight into how they situate science relative to other aspects of their identities that are important to them. While I did not follow students outside of the school, I gathered data on students’ lives through conversations, journals, and their creation of home ethnographies.
To address the research question regarding classroom conditions and teacher practices that were more conducive to a greater number and diversity of students participating, using science discourse, and developing a sense of group membership, I compared participation of different students across activity structures, topics, and over time. Methods of analysis included counting how frequently students made negative comments or supported each other’s learning. I compared my own counts with some conducted by the student researchers, to check the coherence of my interpretations with those of the students. In looking to see how students constructed themselves and each other relative to science and school, I used discourse analytic techniques that included examining double-voicing, indexicals, deictics (Wortham, 1996), semantics, grammar, subject choice, exclamatives, and appraisal (Eggin’s & Slade, 1997). These methods helped increase understanding of how school discourses and associated schemas are reflected in students’ talk, and how identities are constructed through social interaction.

While observations, interviews, and other data resources at the level of everyday interactions, or the “meso level,” can provide some insight into the overall relationship between teacher practices and students’ sense of membership in a group centered on science, these methods are not conducive to analyzing isolated interactional events. Therefore, I employed microanalysis techniques to examine the particular conditions surrounding when students became entrained or failed to become entrained in the classroom and to record the symbols and language circulated and/or generated. To compare chemistry and physics interactions,

I used the I-Movie video editing program, which allowed for the creation of short video vignettes and slowing the videos to a 10th of a second.
I examined body language, gaze direction, rhythm of speaking, gestures, and synchrony or asynchrony in movements and facial expressions. While coordinated movements suggest entrainment and common gaze direction suggests a mutual focus, asynchronous movements provide evidence for a lack of entrainment. I have also transcribed and analyzed some of the classroom dialogue, examining patterns involving whether talk was characterized by overlap, pauses, interruptions, changes in volume, participants finishing each others’ sentences, and timing between the ending of one participant’s utterance and the beginning of another’s. I interpreted anticipation of utterances as evidence of the buildup entrainment and solidarity, and lack of coordination, such as pauses, hesitation, and asynchronous vocalizations as evidence of a lack of entrainment (Collins, 2004).

One possible issue to consider with this approach to micro-level analysis is that certain details, such as the appropriate length of a pause, may vary between cultural contexts. However, within any given social setting there are still shared ways of establishing, maintaining, or breaking the rhythm of a conversation, with consequences for group solidarity. Collins (2004) addresses this issue of variability in the meaning of interactional events:

“No gap, no overlap” may be culturally variable. . . This suggests a reformulation, but not necessarily a rejection of the model of conversation as solidarity-producing rhythmic coordination. The key process is to keep up the common rhythm, whatever it may be. Where this is done, the result is solidarity; where it is violated, either by speaking too soon or too hesitantly, the result is felt as aggressive encroachment or alienation, respectively. (p. 24)
Given the setting of this study in Philadelphia, and the norms of interaction both within the classrooms and among the students, it can be reasonably assumed, for example, that anticipation of each other’s utterances suggests a solidarity-producing interaction whereas uncoordinated side-talk suggests a lack of solidarity among the class as a whole. In addition, regardless of the norms regarding the rhythms of interaction in any particular setting, changes in these rhythms can be indicators of either the buildup or the reduction of entrainment and solidarity. Attending to these changes was an important part of my analysis.

Successful IRs are not only identifiable at the micro level through examining vocalizations and body language. For an IR to have been successful, participants should also have a conscious awareness of emerging feeling energized about the activity and the group. Part of the methodology therefore included having the student researchers and teacher researcher review the same vignettes of classroom events that were analyzed at the micro level and describe how they felt about the class, the subject, and the other participants. Identification of successful IRs at the micro level was compared with the student and teacher researchers’ descriptions of interactions at the level of everyday experiences in order to examine whether there were coherences and/or contradictions.

During an entire school year, much more data were collected than could be analyzed in detail, as we had approximately 35 hours of videotape. There were a variety of approaches that we used to select particular vignettes for more detailed analysis. For each class session, Ms. Loman, one of the students, or I created a video description, in which we recorded the sequence, topics, and participants in identifiable phases of activity and interactional events. We used the CVide software to outline the sequence for some of the videotapes, whereas for others we recorded the times and events in Word documents. After the events were recorded, the student
researchers and I coded incidents relevant to the research questions, such as times when there were breaks from IRE dialogue, when the teacher did not know an answer, and when students used canonical science language. These video descriptions allowed for the purposeful sampling (Strauss & Corbin, 1994) of short vignettes that were relevant to the research topics and were representative of other interactional events throughout the data set. We could then examine these smaller segments at the micro level, using video analysis and/or discourse analysis. While we could not do a comparison of every class session that took place during the school year, we compared similar types of class sessions, such as reviews for tests in physics and reviews in chemistry.

In the next sections, I draw on data from the classroom to examine the variability in students’ perceptions of the accessibility of science as a “status group,” and the implications for the development of solidarity among students surrounding science.

**Results**

Most of the physics classes took place in teacher-centered IRE dialogue. Counts done across similar activity types between physics and chemistry classes indicated that there were fewer student-generated questions during physics classes and there were fewer departures from IRE dialogue. In addition, there were some students, mainly from the lower performing elementary schools, who volunteered to speak very infrequently and did not often use science language, although they knew some of the words and concepts and would use them when speaking within smaller groups.
In one meeting with the student researchers toward the beginning of the year, the following discussion about student participation took place:

Monique: I think everybody wanna participate
Aileen: They be scared to. I know I used to be scared
Monique: I don’t think everybody wanna participate when they gotta raise their hand and answer questions and all that. I think that they just want (inaudible).
That’s how I feel.
Ms. O: So you don’t think everybody wants to be talking in the class or get a chance to talk in front of the class.
Monique: No cause they might think that they gone say something that /stupid/ or something. Cause like sometimes . . . like some people. . . like Ms. L she be like. . . like. . . if somebody say something off the wall and you be thinking the same thing. . .
Ashley: /wrong/
Monique: and you be like. . . and she be like that is real. . . ‘she don’t say it like ’that’s stupid’ but she say like in a way. . . you understand that was a stupid question. But like you still don’t get how it’s a stupid question.

Ms. Loman may not have actually thought that these students’ questions were stupid. However, the fact that this was Monique’s perception, and that the other two students seemed to concur, suggests that there were aspects of the classroom interactions that were reducing the effectiveness of this classroom as a learning environment. If students feel that they must keep
silent in class and not ask questions, there will not be sufficient opportunities for building
solidarity with the teacher and they will not learn to use the language of science more effectively,
a key element in what it means to learn science (Lemke, 1990).

If students do not ask questions for clarification, what happens when Ms. Loman is
speaking about something that they do not understand? I will describe one illustrative example
that shows how students often engaged in backstage performances rather than engage with the
teacher, as they were intimidated by her front-stage performance, which perpetuated a view that
science knowledge and language were inaccessible. This vignette was chosen because it is
representative of other similar events.

Toward the beginning of the year, Ms. Loman taught the students about velocity and
acceleration, using graphs. In one particular class in October, some of these students appeared
very confused by the symbols used in a displacement versus time graph that Ms. Loman drew on
the board. Ms. Loman was using the letter “S” to denote distance, which is standard in high
school physics textbooks. However, using the letter “D” would have probably been clearer to the
students, since “D” is the first letter of the word distance and these students had not been using
high school physics textbooks. While Ms. Loman was drawing the graph, many of the students
were not looking at the board or at Ms. Loman, suggesting a lack of entrainment and mutual
focus in the classroom. Aileen and Angela, however, were focusing on the board and laughing
together.

Angela: S stands for time
Aileen: No, that’s seconds.
Angela: It’s meters!
They were obviously confused by the graph, but never raised their hands and asked Ms. Loman to clarify. On the basis of later interviews with these students, they likely felt intimidated out of engaging in a front-stage performance, where there seemed to be a clear expectation that successful and accurate performance were primary—this was not a rehearsal. As a result, they were unable to build solidarity with Ms. Loman or with the whole class surrounding science, but judging from their laughter and coordinated body movements, they were successful at building solidarity with each other in the backstage. They engaged in their own talk, with “science teacher drawing graphs” as a mutual focus for their interaction, rather than attempting to engage with the material directly. Although they had a private interaction, which can be considered disrespectful toward the teacher, they spoke quietly and Ms. Loman did not even notice their side conversation. They maintained her performance of being an effective teacher of science.

Goffman (1959) discusses the signs people give to each other to let each other know that they have not bought into a performance, particularly when the performance is one of deference. In this case, they appear to Ms. Loman to be paying attention to the content, but let each other know that they do not really “buy in.” Perhaps more importantly, they avoid being humiliated by not subjecting themselves to participating in this front-stage performance when they were clearly just beginning to access the tools and language necessary to perform.

Much of learning is about what goes on backstage—the rehearsing of lines, the making and arranging of the props, and practicing a stage fight—these awkward attempts are not ready
for the judgmental eye of a critical audience. Yet performing for a critical audience is the situation in which much classroom learning actually occurs, under conditions of social distance maintained by the teacher’s performances of expertise.

In an ideal classroom, students would be learning new symbols and gain a facility with using them. However, in this instance, the obscure symbols that Ms. Loman is using do not serve to unify the group, nor do they serve as an educational experience for these two students. Instead, the students seem to perceive their use as unnecessarily exclusive, serving as cues to separate those who are members from those who are not. Aileen has frequently stated that she believes teachers use hard language intentionally so that students will not understand. In Aileen and Angela’s private backstage performance, they have the freedom to mock the language that excludes them.

Of course, being exposed to and using new language and symbols is part of learning science. However, the ways in which this language is introduced, whether it is perceived as intentionally exclusive, and whether students feel that they are able to ask questions makes a significant difference in whether classroom interactions surrounding science will build solidarity and therefore group membership, or whether students will withdraw and engage in their own backstage performances instead. Just as Aileen believes that language can intentionally exclude, Monique has expressed similar views, “I don’t think they really want us to understand.”

These comments in conjunction with many instances of classroom behavior over the year suggest a view of science not as a community that all students can join, but as a status group where complicated language marks members from nonmembers. By presenting material in ways that students perceive to be high-status and inaccessible, some students’ sense of group membership in science, and consequently their interest and learning, is adversely affected. It is
possible that these students’ test scores would have been better had it been an environment in which they felt like they could engage directly with the teacher.

It should be noted that one goal of cogenerative dialogues was for students and teacher to discuss issues such as this one. When Ms. Loman became aware that her language was perceived as intentionally exclusive, she worked on changing some of her practices. In a reflective piece on this particular incident, she writes, “Because of conversations like this one I became more aware of how intimidating the symbols and math were in physics. By making a concerted effort to be consistent and offer explanations about what symbols represented I tried to take some of the mystery out of the work placed on the board. These changes in structure transformed my classroom and students saw the effort I was making to become a better teacher.”

While exclusionary language makes it difficult for most students, it can have a particularly negative effect on groups that are not often represented in science professions or in the media. The following vignette was chosen because it is representative of other incidents throughout the year that suggest that the use of science language was more risky for students whose categorical identities did not match with images of “good science students.”

In this incident, Samir, an African American student, is called on to explain why a can was crushed and filled with water in a demonstration in which Ms. Loman heated up a soda can with water, which forced the air out of the can and replaced it with water vapor. The can crushed because cooling led to the condensation of the water vapor and consequently, low pressure inside the can relative to the surrounding air.

Transcript
Ms. Loman: Look how much water is in here. Was there this much water before?

Samir, what do you think?

Samir: The cold water diffused into the can.

Ms. Loman: The cold water diffused into the can?

Student #1: "What!!"

Student #2: George Bush

Student #3: Yeah, George Bush

Student #4: (inaud) big words

Other students:

(laughter and mumbling)

Ms. L. Shh. Let’s let Samir finish please! Dave. (2) Samir, please finish your thought.

Samir: All right. The reason why it tried to get in is because there wasn’t no cold water in the can and (.3) it (.3) since it was a low concentration of cold water in the can, it was a big concentration of cold water inside the pan.

The cold water diffused into the can 'cause

Ms. Loman: It, like, went through the sides?

Samir: No.

Ms. Loman: No. It went through the top, the opening, okay.

Samir: Because (.2) um (.2) in diffusion, if it a area of low concentration in a
area of high concentration, the high concentrated area goes into the low concentration area.

Ms. Loman: Okay. This is an interesting idea that is talking about biology, but bringing it into Physical Science.

Goffman (1959) describes how in teams, a participant can be shunned or ridiculed for stepping out of their prescribed role. In Interaction Ritual (1967), he also describes the risk of claiming a face for oneself that others will not support. Samir’s use of the science vocabulary word “diffusion” can be seen as this type of interactional move, a claim to membership in the status group of science. However, this move was not accepted by the students and did not appear to be accepted by Ms. Loman initially either. While in the end Ms. Loman recognized Samir’s response as an “interesting idea” and an attempt to apply concepts from biology to physics, her initial questioning of Samir’s answer and her interruptions might have been interpreted by the students as not accepting Samir’s use of the language and consequently his claim to membership in a science-related status group. In reviewing this video, the student researchers describe how the teacher “thought his answer was dumb.”

The students’ backstage interaction, which began after Ms. Loman repeated Samir’s answer, seemed to be a solidarity-producing experience for those involved, in that they were laughing, repeating each other’s words, sharing a mutual focus on Samir’s answer, and drawing on the common symbol of “George Bush” that may not have had positive associations for them but at least served as a source of humor. The interaction cemented the ties of many students, who had a solidarity-building experience at Samir’s expense.
Interestingly, the students did not correct Samir’s explanation. They did not seem to believe that he belonged in a science membership group, but they left it to the teacher to respond in ways that would confirm this. The student researchers interpreted the “George Bush” comment for me at a later time. Although these were not the same students who made the comments, they are in the same peer group as those who did and were laughing at the time. Therefore, it can reasonably be assumed that they can correctly interpret the meaning and the accompanying laughter.

Aileen: You know, George Bush and the big words.
Ashley: That he does not know how to use.
Aileen: So he should not use them.

In their verbal responses to Samir’s explanation, the students in the class had made a direct and interesting analogy: both Samir and George Bush use complicated language incorrectly and in ways that claim a particular status that they do not legitimately have. Just as they reject aspects of George Bush’s claims, possibly to being an educated person (although one can only speculate, as I did not ask the students directly), the students also rejected Samir’s claim to membership in a science-related status group. However, Samir’s definition of the word diffusion was correct, although he did not provide the correct explanation for the phenomenon observed. After the interaction, Samir shrank in his seat a little, suggesting that he may have been experiencing shame, which Goffman (1967) describes as one result of an audience not accepting one’s face.
How does race emerge as a factor? While such a link cannot be proven, the student researchers’ statements about the incident and observations of classroom interactions over time support the link between Samir’s race and the lack of support he received from his classmates for his “diffusion” answer. On this day in particular, Samir’s comment should have been accepted, given the other types of interactions that had taken place surrounding the demonstration. While during many physics classes only a few students tended to use science vocabulary in developing explanations, in this session, more students than usual volunteered ideas that incorporated science language. Their willingness to do so might have been related to the buildup of EE and solidarity during the demonstration. Furthermore, students’ contributions were for the most part accepted by their peers in this session. Therefore, the negative response to Samir’s comment is salient, and suggests that students were particularly unsupportive of his claims to membership in a science-centered community.

As an example of how some of the White students were received, one White female student, Erin, was not initially able to develop a scientific explanation when asked by Ms. Loman to explain Bernoulli’s principle, “in your own words.” She hesitated for a while, and was prompted by the teacher, “OK, in any words.” While this seems like an opening for student laughter at Erin’s failure to come up with some explanation, there was silence in the classroom. Erin’s final explanation was a little unclear, and drew on science vocabulary.

However, no student ridiculed Erin. While Erin’s and Samir’s use of science language were just two incidents in this particular class session, they are indicative of a larger pattern where students were more likely to reject some students’ claims to being a member in a science group than others, and more often it was the Black students who were silenced.
In looking over the entire transcript of the session, it could initially seem like there was a contradiction to this pattern. Aileen, who has aspects of her identity that are similar to Samir’s in that she is African American and does not achieve at high levels in science, was able to use science language in her explanation yet still did not receive a negative response from her peers. However, on closer examination, her contribution differs from Samir’s in some significant ways. She said, “Well, since Lisa said that the can water molecules are. . . you know. And the water in the pan isn’t. . . you know, then when you turn the can over into the water in the pan, then the water in the pan will move like the water in the can.” Rather than making a direct claim to membership in the science community through her use of the word “molecules,” she voices a higher achieving, multiracial student as having originally used the word. In addition, she does not complete the sentence about the molecules, but says, “you know,” the implication being that others know. These interactional moves suggest that she was purposefully trying to avoid claiming a face that others would not support. While this comment does not serve as evidence that Aileen was treated differently because of her race during this particular class session, her action of qualifying her claims to membership suggests that she anticipates that they might be rejected. On other occasions, she has said that some White students at City Magnet make negative comments about people’s wrong answers and care only about their grades. Both this incident and her comments suggest that race has had a role in how students’ contributions were received in science classes.

The different treatment of students based on race is supported by the comments of Ashley, a student researcher, who reviewed the videotape with Samir and described how the students were “insulting” him. I asked her whether students insult each other in this way because there is pressure not to use science vocabulary. I did not mention race. Ashley said “sort of” but
that that it also “depends on who is using the words. Samir is Black and people do not expect Black students to be good at science, plus he is not a particularly good student anyway. So people react that way if he tries to talk like that.” Ashley’s thought was that Samir’s claims to membership are questioned not only because he is a student, and not a particularly diligent one, but also because of his race. On another occasion, Ashley described more in detail about how race comes into the issue of who should succeed in science. Again, she was not asked about race, but was asked to clarify something she said about some students being “uppity.” I note this because it is important that I did not prompt her to talk about race, but that she did so on her own accord.

People believe that people who excel in science are often “uppity” or a part of the elite class. I think the way people view those who excel in science. . . depends on their culture, surroundings and upbringing. For example all of my friends who are black tend to just get by in science. They remember enough to pass the test but they rarely retain the information. My friends of other races (Asian and white) tend to grasp science and majority of the time they know more than the class requires you to know. I have Physics AP this year and besides one other person I am the only black person in my class. . . So sometimes when they are talking about stuff I don’t understand, I tend to feel outnumbered and I begin to feel as if I don’t belong. It is situations like this that may lead students to choose not to be a part of the “elite” science group. Even though a child may be good in science no one wants to be outnumbered so they may choose not to show their full potential in a science class.
Of course, Ashley is only one student, and it is possible that others would disagree with her. However, her perspective of the problem of science being an elite status group that can restrain participation more so on the part of Black students correlates with actual patterns of participation in this class.

Certainly the impact of race, gender, ethnicity, and other types of identities on membership in science is not deterministic. In spite of her discomfort at being a minority in her physics class, Ashley is a very good science student. She has described how her parents think she can accomplish anything, that she wants to set a good example for her nieces, and that she wants to do well because her friends would like to hear a Black person’s name to be called at graduation for an award. Perhaps her parents and peers are voices in her internal conversation that serve as a source of support and pressure to succeed. However, her doubts about whether she belongs because of her race are also part of her internal conversation and may prevent internal solidarity when thinking of herself in relation to science. She says that she is not good at science, although her grades are good. In the entire year that I observed her, she rarely volunteered to answer questions, nor did she use science discourse in front of the class.

What is the tie between categorical identities such as race and gender, and situational identities, such as one’s identity as a science student? Certainly one influences but does not determine the other. For Samir, both his race and his reputation as a student influence his acceptance into a status group associated with science. Whether Samir develops an identity associated with the practice of science will not be just because he is Black, or just because he does not get high grades, or because science language is unfamiliar and indicative of a certain status. Yet all of these issues can be seen as informing how teachers and students treat Samir, which can influence whether he will experience solidarity in science classes and whether he will
experience internal solidarity in these situations, or whether negative self-talk will emerge instead.

It is possible to view the incident with Samir as a successful IR in that students built up entrainment in their comments about Samir’s response. However, the solidarity was not centered on science-related symbols, and it did not include the whole class, as Ms. Loman, Samir, anyone who did not make fun of Samir, and people who did not appreciate the comments about George Bush were excluded. Certainly Samir would not consider his experience a successful IR, and his feelings of solidarity with his classmates were lessened rather than increased. A “chain” of failed IRs such as this one may result in students avoiding opportunities to use science language and procedures in the future and failing to develop feelings of group membership in science-related communities.

This section drew on illustrative examples to show how in physics, the idea of science as an exclusive status group was inadvertently reinforced by actions on the part of the teacher and was picked up by the students. Some of the students responded through backstage performances that did not focus on science language. Yet if students are to identify with science, they need to develop feelings of membership associated with science, rather than perceive it as a status group that is not open to them. In the next section, I draw on one example to show how Ms. Loman’s actions when she was out of field reduced the social distance between teacher and student and facilitated solidarity surrounding science. The vignette was chosen because it is representative of other similar events in which Ms. Loman was unsure of an answer, yet students responded in a positive way through increasing rather than reducing their science-related talk.

Chemistry Interactions: Reduced Distance Among Students, Teacher and Science
During one class session in January, Ms. Loman decided to use a compound from one of the equations in the textbook, H₃PO₄, as an example in order to show how in neutral compounds the atomic charges add up to zero. She wrote H₃PO₄ on the board and began adding the negatively charged ions and positively charged ions, calling on individual students to look at their periodic tables and tell her the charges. However, this example did not work because PO₄ is a covalently bonded ion with a charge of −3 and the charges of the individual atoms therefore do not add up to zero. When her example did not work, there was a long silence followed by Ms. Loman’s statement, “It’s not neutral. Why did this happen?” Such an occurrence can be awkward for a teacher. However, rather than becoming frustrated or bored, all but one of the students that the camera could see were attentive, their gaze fixed on the board. Ms. Loman’s mistake had become a very effective mutual focus.

Ms. Loman asked me to step in because of my knowledge of chemistry, and said, “Miss Olitsky is going to explain this because I’m curious.” She also said to me, loud enough for the students to hear, “you’ve gotta do better than I’m doing right now.” While this may seem like a somewhat unusual situation because most out-of-field teachers do not have researchers in their classrooms that happen to be familiar with the subject, it was not unusual for Ms. Loman’s students to see her consult other adults for help. On days that I did not attend the class, Ms. Loman would go next door and ask the chemistry teacher, Ms. Mackey, for help. Similarly, Ms. Mackey, who was more proficient in biology and chemistry, would ask Ms. Loman for help when she was teaching physics. In this school, the two teachers had developed a collegial relationship, and it was acceptable for teachers to leave their rooms for a moment to consult another teacher. In this instance, Ms. Loman positioned herself as a “curious” learner, as prone to
errors, and as someone who thinks another can “do better.” Saying one is “curious” about one’s own error is an atypical move for a teacher, but it is what science educators might want students to experience: a curiosity about a problem and a desire to call upon available resources to solve it. In some ways, Ms. Loman brought her backstage preparation into her front-stage performance, as the students were allowed to see how she struggles to figure things out just as they do.

Overall, students seemed to respond in a positive way to Ms. Loman admitting when she did not know an answer. In this particular incident, they did not form their own “backstage,” making fun of Ms. Loman for not knowing, or disengaging from the main activity because of frustration with the mistake. Instead, they remained focused on the board and provided a coordinated chorus of loud “Ahhhs” after I explained the reason for the error. There appeared to be an entrainment in noisemaking and gaze direction and a building of solidarity in this class extending around the chemistry content. After the explanation, Angela raised her hand. “So when you have covalent... covalent bonds how do you find what out their... their... new charge is?” This is the kind of question that many teachers would be very pleased with, as it demonstrates curiosity and understanding. Angela appeared to be struggling to get the science vocabulary words out, repeating “covalent” and pausing before “new charge.” However, there is no student reaction rejecting her claim to be a member in a science community through her use of language, although like Samir, she does not get good grades in science and she is Black. Of course, this is only one example.

However, this one incident is illustrative of an overall pattern in chemistry where more students seemed willing to take the risk of using science language and were less likely to have their comments not accepted by other students.
Student researchers’ comments support that Ms. Loman’s out-of-field teaching had benefits for fostering entrainment and solidarity in the classroom. Ashley describes, “Teachers should know the answer, but when they don’t it does get more students to pay attention.” Aileen once said to Ms. Loman, “I hate to tell you this Ms. L but we kind of like it when you make a mistake. No offence.” These mistakes seem to be interesting to the students partially because they reflect a deviation from the regular performance of a teacher as someone who knows everything.

Yet rather than losing authority in the class, Ms. Loman’s particular responses to being out of field seemed to have the positive results of greater student comfort participating in chemistry. Aileen also has said, “It is good when a teacher makes a mistake. Then I don’t have to feel so stupid if I don’t know something.” Monique describes her experiences when Ms. Loman was out of field, “We could see that Ms. Loman had to learn stuff too, she did not know everything. Sometimes you are good at one thing and bad at another, well not bad, but you have to learn it. So I felt less stupid asking my friends questions so I could better understand.” Angela, who is not a student researcher, said in an interview, “I don’t know—physics is more related to my daily life but something about chemistry made it more fun. I think because it felt like we were all learning it together.” While the students still recognized that Ms. Loman’s knowledge of chemistry was much stronger than their own, these and numerous other student comments suggest that students were not as afraid of Ms. Loman judging their comments and questions in chemistry. I do not wish to suggest that this was merely because Ms. Loman was out of field. One could imagine another out-of-field teacher who rather than showing students a “backstage,” instead overdramatizes a performance of being authoritative. Student comfort was an outcome of Ms. Loman’s particular responses to her own lack of subject knowledge. It is
likely that experiences of being backstage with the teacher contributed to greater interpersonal solidarity between the teacher and students, opening up more possibilities of solidarity-building interactions surrounding science.

**Limitations**

One question regarding these findings relates to whether they are applicable in other types of school settings. For example, it could be argued that perhaps the students in this urban magnet school would be more tolerant of teachers’ mistakes than in other schools, as these students were selected to attend City Magnet, perhaps in part because they have a greater disposition to respect their teachers. However, some of the experienced teachers in the school described how one of the more challenging aspects of City Magnet was that students (and their parents) frequently questioned their knowledge and legitimacy. Therefore, the fact that the students in this class did not lose respect for Ms. Loman, and that some of them believed that they benefited from Ms. Loman’s out-of-field teaching, was particularly significant.

Another possible issue is that these students may be more willing to affiliate themselves with a group centered on science learning than other students would be, as they are in a magnet school and are therefore at least somewhat committed to school success. Observing their teacher in the “backstage” of learning may therefore be a particularly valuable experience for these students, as they may feel excluded from science as a high-status group but they value academics and are therefore open to the possibility of membership. It would therefore be important to conduct further research in order to see whether the findings in this study apply to other types of school contexts.
Learning science is not just a cognitive endeavor, as it entails developing a social identity associated with scientific practice and discourse. To acquire such identities, students need to develop feelings of group membership associated with science, which can emerge out of solidarity-building interactions in the classroom. However, the portrayal of science language as a boundary marker to prevent newcomers from entering an elite, high-status group, rather than as a mutual focus for successful interactions that involve the whole class, can interfere with solidarity by having a negative influence on students’ comfort level talking science and an association of science language with low levels of EE.

In this classroom, some students’ preferences for and increased participation during chemistry rather than physics related to the levels of EE associated with science language, which were influenced by changes in how Ms. Loman handled the issue of expertise and how she managed her teaching performances. When Ms. Loman was in field, she frequently presented an authoritative, front-stage performance, mainly in the form of IRE dialogue, with unfamiliar language that some students perceived as indicative of membership in a status group that they could not join. Students, particularly those from minority groups who are not as well-represented in science, risked “losing face” and feeling shame if they used such language awkwardly or incorrectly.

It is understandable for students to treat the teacher as the main authority with regards to science knowledge. However, perhaps a centralized, hierarchical view of where science knowledge rests and the invisibility of the teacher’s backstage as a learner has a negative influence on the discursive aspects of science learning if students see their contributions as
unimportant, do not believe that it is necessary to struggle to understand, and do not view themselves as potential members in a group centered on science learning. Rather than interactions that increase the cohesiveness of a status group that would include the students, interactions may be more significant in their power dimensions, with a loss of EE for students who are positioned as not knowledgeable.

This case study reveals that although unplanned by this particular teacher, while out of field, Ms. Loman allowed students into her “backstage,” where they could observe adults in the process of learning in a social context. This experience countered the prevailing views of science as too hard, promoted a view of knowledge and authority as distributed among members, and encouraged the discursive practice of science. The resulting solidarity building classroom interactions surrounding the use of science discourse decreased the need for students to engage in backstage performances in order to gain EE. In addition, students felt more able to take the risk of being “wrong,” which is vital to learning, as without taking this risk their opportunities to receive scaffolding from teachers or other students are reduced. Of course, there were still many disadvantages to Ms. Loman’s being out of field.

However, a teacher does not have to be out of field in order to obtain some of the positive results that emerged in Ms. Loman’s chemistry classroom. In physics, students could also have been given a “backstage” view of Ms. Loman’s learning processes and might have therefore perceived science as somewhat more accessible. Ms. Loman has described how participating in this research process has changed her in field teaching in subsequent years, based on what she learned from the comparison between her physics and chemistry teaching. There is potential for other teachers to employ strategies similar to Ms. Loman’s without going out of their field, such as by modeling the accessing of resources, perhaps even by inviting adults with different areas of
expertise into the classroom. Another possibility would be for teachers to present difficult material in ways that highlight rather than de-emphasize potential sources of confusion, as these can serve as mutual foci and as opportunities to practice problem solving and argumentation, or to observe adults doing so.

If classrooms are to function as learning communities, more attention needs to be given to whether interactions provide students with opportunities to develop solidarity with others through the use of science language. There is no inherent reason why students should disdain their own knowledge and be afraid to use science language or try out new procedures. While teachers do not have complete control over a classroom environment, this study suggests that the ways in which they “perform” as science teachers can have a considerable influence over the types of interactions that ensue and whether science language is associated with a gain or a loss in EE. These interactions affect whether students develop a sense of group membership and have the incentive to develop the relevant skills, dispositions, discursive practices, and identities for participation.
References


