Supporting Teachers in Scientific Discussions in Project-Based Learning Environments

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Abstract

One of the goals of project-based science is to promote scientific discourse communities in the classroom through dialogic discussions. Having scientific discussions in the classroom is a complex process, yet the development of curriculum materials does not reflect that complexity. In addition, there is little research on how curriculum materials have developed or could help teachers enact scientific discussions with students in project-based science. To address that gap in the research literature, this study analyzed the curriculum supports and embedded educative features for the enactment of science discussions in one project-based genetics and genomics curriculum. Through a comparison of the discussion supports of the curriculum and the subsequent classroom enactment, we found that there were few developed supports in the curriculum materials and few dialogic interactions between teachers and students. We also observed an increase in inquiry-based discussion practices by the teachers with increased supports, but a prevalence of IRE recitation discourse patterns. Drawing from these results, we speculate on issues that may contribute to the pervasiveness of IRE in science discussions, offer a different view of project-based science curriculum materials development and argue for new methods of teacher supports in project-based science.

Introduction

Reform efforts have moved curriculum development toward the promotion of inquiry-based practices (National Research Council (NRC), 1996, 2000) through the use of project-based science (Blumenfeld, Marx, & Harris, 2006; Krajcik et al., 1998) and teacher use of curriculum materials in decision-making during enactment (Ball & Cohen, 1996; Remillard, 1999; Schneider & Krajcik, 2002). Many scholars have investigated the effects of social aspects of classroom environments on learning (Greeno & Middle School Mathematics Through Applications Project Group, 1998) and argue that learning environments and activities should be organized to include opportunities for acquiring basic skills, knowledge, and intellectual activity as contributions to students' development. Through such opportunities, students become effective participants in the meaningful social practices of their learning communities in and out of school.

Opportunities for the exchange of ideas is a necessary component of project-based science. As students talk about scientific phenomena with each other and their teacher, they can be socialized into the culture and discursive practices of science as a discipline (Krajcik & Blumenfeld, 2006; Krajcik et al., 1998; Singer, Marx, Krajcik, & Chambers, 2000). However, studies have shown that during project-based science instruction, classroom discussions can be problematic as students struggle to navigate through several types of classroom and scientific discourses (Moje, Collazo, Carillo, & Marx, 2001). Thus, there is still much to be learned about supporting the development of scientific conversations and discourse in the classroom. Although engaging students in science conversations and discourse is emphasized in project-based science, it is still unclear how curriculum materials are to promote this goal.

In the context of this study, we refer to classroom discourse as whole-class discussions, and explore how whole class discussions are supported in teaching materials that promote inquiry-based instruction. We also look at the kinds of teacher-student interactions that transpired during the enactment of a project-based curriculum. Results will show that where curricular supports were low, classroom discussions were dominated by teacher monologue and low student interactions. With higher amounts of curricular supports, teachers exhibited inquiry-based practices during discussion enactments, but still engaged in IRE recitation patterns.

The purpose of this study is to understand whether embedded curricular supports are sufficient for promoting the enactment of inquiry-based discussions in project-based science classrooms. This study is one outcome of our efforts to systematically capture and analyze curriculum materials and the resulting classroom discussions by using research studies that identify the important aspects of classroom discourse in science as criteria for effective discussions. Through our analysis of the curricular supports and teacher enactment, we made conjectures on issues that may contribute to the pervasiveness of IRE in science discussions, consider different perspectives in the development of project-based science curriculum materials, and argue for alternative methods of teacher supports in project-based science.

Literature Review

Science Learning Through (D)iscourse

Magnusson, Palincsar and Templin (2004) argue that scientific knowledge does not automatically arise out of independent exploration of the physical world, but is an expression of a particular way of knowing the world that developed through the enculturation into particular practices of a community of scientists. In an ideal inquiry-oriented science classroom, the practices of scientists, such as their discourse, or their ways of knowing, doing, believing, acting, reading, and writing (Gee, 1996), are emulated by students. Blumenfeld, Marx, Patrick, Krajcik, and Soloway (1997) claim that by entering into the discourse of science, for example, students learn ways of knowing in the discipline, what counts as evidence, and how ideas are validated and communicated. In project-based science classrooms, the creation of discourse communities is argued to help students ask questions, write explanations, form conclusions, make sense of information, discuss data and present findings (Krajcik & Blumenfeld, 2006). The challenge, however, is the integration of scientific discourse into the learning experiences of students. Curriculum materials that promote discourse in science are not often explicit about how to enact rich, open-ended scientific discussions in project-based classrooms (Moje et al., 2001).

Specifically, Moje et al. (2001) show that the enactment of project-based classroom materials draws on a variety of discourses, including the discourses of science, instruction, and everyday life. Within the science classroom, several discourses compete with one another, and when teachers and students are not explicitly supported in navigating those discourses, the creation of a scientific discourse community in the classroom becomes challenging (Moje et al., 2001).

Here, I refer to discourse in the classroom as the instructional and interactional discourse in science (Moje et al., 2001). This type of discourse focuses on the cultural demands of negotiating different ways of knowing and speaking. Although discourse specific to the discipline of science is important, this study investigates communicative competence within the norms of classroom practice by looking at the interaction patterns between teachers and students

Monologic vs. Dialogic Interactions and Inquiry-Based Instruction

Classroom discussions come in a variety of structures, including the IRE (initiate, response, evaluate) recitation or triadic dialogue (Lemke, 1990; Mehan, 1979). Lemke (1990) claims that the triadic dialogue sets a disadvantage where the teacher tends to control the direction of the discussions and the students have few opportunities for initiative. Teachers maintain the advantage of initiating exchanges, setting the topic, and controlling the direction in which the topic develops. Within this structure, students have little control directing the discussion or contesting teacher prerogatives (Lemke, 1990).

In this monologic style of classroom communication, information is transmitted from teacher to students and there is little opportunity for student contributions (Wells & Mejia-Arauz, 2006). Although monologic communication has its purpose and value, it does not align with the discursive demands of project-based science (Polman, 2004), or for the construction of knowledge (Wells & Mejia-Arauz, 2006). Students with alternative perspectives on a topic may need opportunities to be brought into the arena of communication where there is an attempt by the speaker and listener to understand the perspectives of the other, thereby promoting student participation in inquiry, discourse and reasoning.

Alternatively, dialogic discussions in the project-based science classroom are complex because spontaneous engagement in scientific talk among students is rare (Lemke, 1990; Moje et al., 2001). In dialogic interactions, the teacher encourages students to put forward ideas and explore and debate different points of view. In addition, students' responses are often tentative suggestions based on open or genuine questions, spontaneous, and expressed in whole phrases or sentences (Chin, 2007).

In the ideal project-based classroom that promotes inquiry practices, dialogic discussions are the primary goal of instructional and interactional discourse. As students develop cultural skills of negotiation and questioning skills in science, they become active members of the scientific community while continuing to remain learners with agency, rather than passive receptacles (Polman, 2004). However, Nassaji and Wells (2000) claim that even with efforts of fostering dialogic discussions in science classrooms, triadic dialogue continues to be the dominant discussion structure. Due to the prevalence of triadic dialogue in project-based classrooms, teachers need substantial support in finding ways to integrate and manage competing discourses (Moje, 2001) and move classroom discussions towards dialogic interactions.

Instructional and Interactional Discourses: Practices of an inquiry-based discussion

Using literature focused on inquiry-based discussions, we have created a literature-based framework of instructional strategies (see Table 1) that have shown to increase student engagement in whole-class discussions. As mentioned earlier, traditional IRE or triadic dialogue (Lemke, 1990; Mehan, 1979) tends to promote recitation of corrects answers without further elaboration or exploration of ideas. However, to make discussions more dialogic and inquiry-based, Nassaji and Wells (2000) have shown that altering the evaluative portion of the triadic dialogue to include non-judgment evaluations, such as follow-up questions (IRF) progresses discussions towards dialogic conversations. In addition, Chin (2007) has shown that initiating questions that require students to confront prior knowledge, rather than recall questions can also promote dialogic interactions.

One important feature of inquiry-based discussions is students' ability to make knowledge explicit (Moje, 1997). Within project-based science discussions, students are required to weigh evidence presented by several of their classmates, looking for the most appropriate solution based on scientific reasoning and theory. Thus, it is important to carefully select one's tools of expression so that the significance of one's work is best signaled to the community (Magnusson et al., 2004). The use of evidence explained by scientific reasoning may act as a communication tools, help demonstrate student knowledge of science and contribute to the dialogic nature of a discussion (Kuhn, Kenyon, & Reiser, 2006; McNeill, Lizotte, Krajcik, & Marx, 2006). Students should not only "get the right answer," but also learn to participate in a discussion involving several classmates with potentially different viewpoints and ideas, while using evidence and scientific reasoning to justify their thoughts and ideas.

In inquiry-based discussions, the development of classroom norms must be an ongoing process between the teacher and students. Teachers may help students develop collaboration skills, including turn taking, listening, and respecting others (Krajcik, Czerniak, & Berger, 2002). The teacher also manages the discussion by avoiding a highly competitive environment and by helping students see that divergent results are a product of activity (Magnusson et al., 2004).

Magnusson et al. (2004) describe three dimensions of teacher activity that encourages student enculturation into a community of practice. In the first dimension, teachers establish and maintain the conversational norms of everyday discourse through proper etiquette. In the second dimension, the teacher supervises and manages the intersection of everyday and scientific discourses by helping students move back and forth, and make connections between everyday and scientific language. In this dimension, teachers can provide a metascript, “revoice’ student responses, serve as the collective memory for the class, and provide additional ideas that otherwise may not have been said, also called “seeding” (Magnusson et al., 2004). In the third dimension, teachers give differential responses to students who appropriate scientific norms.

The above mentioned studies have identified several strategies to promote dialogic discussions in science classrooms. In this study, we have grouped them into four categories: (a) Making knowledge explicit through claim, evidence and reasoning, (b) asking questions that avoid evaluative teacher responses, (c) supporting students in communication, and (d) discussion etiquette (see Table 1).

Curriculum Materials and Classroom Discussions

Literature in teacher learning suggests that curriculum materials should include supportive elements in order to be educative for teachers and promote teacher learning (Davis & Krajcik, 2005; Fishman & Davis, 2006), but it is not often that curriculum materials contain such components (Kesidou & Roseman, 2002). Davis and Krajcik (2005) developed design heuristics that provide guidance in the development of curriculum materials that are intended to promote teacher and student learning by providing appropriate and relevant activities, the rationale behind the recommended activities, and classroom adaptation strategies.

In this study, we applied the heuristics to the curriculum materials under investigation as a way to analyze the educative nature of curricular supports for promoting scientific discussions in the classroom. According to Davis and Krajcik (2005), supports for classroom discussions are two fold. First, curriculum materials should provide suggestions and strategies to help teachers promote productive discussions among students and teachers through conversations and student artifacts. Second, curriculum materials should provide the teacher with a rationale for unit activities involving discussions. Curriculum materials are to provide teachers with justification and logic behind intended activities and discussions. Understanding the underlying principles involved in discussions allows the teacher to mold and change discussions as necessary.

Summary of Literature

Student participation in dialogic discussions is one way project-based science promotes the development of inquiry skills, such as learning and appropriating scientific ways of knowing, using evidence to articulate understanding of science concepts, and developing questioning and listening skills. While research shows that the use of a variety of discussion practices enhances the quality of classroom discussions, engaging students in scientific discussions is a complex process. Moje et al. (2001) argue that competing discourses in project-based science classrooms contributes to the complexity of the development of discourse communities and an increase in teacher supports can begin to alleviate the difficulty. The addition of rationales and enactment strategies as educative curriculum features can help teachers enact enacting project-based curriculum materials.

Curriculum Materials and Context of Study

Curriculum Materials

We developed a high school curriculum for $9^{th}/10^{th}$ graders designed to support students' understanding of molecular genetics and genomics. While the materials were designed around National Benchmarks and Standards (NRC, 1996, AAAS, 1993), we also inquired with genomics experts to identify new and important ideas in genomics and genetics that were more current than the Benchmarks and Standards. Our project-based materials used "How SIMILAR or DIFFERENT Are We?" as a contextualizing focus or driving question (Krajcik & Blumenfeld, 2006). The question asked students to make comparisons at many biological levels between themselves and other humans and themselves and other animals. Since hands-on manipulation of genetic data is limited, the curriculum materials promoted discussions to facilitate synthesis of scientific content and sense making. Through this inquiry-based approach to genetics and genomics instruction, increased teacher supports are necessary for engaging students in discussions that encourage students to participate in a scientific community through sharing, rebutting and justifying ideas through scientific evidence and reasoning.

Knowledge Base: Student Learning

To provide a context for student knowledge base, we present data from pre and post test that were collected from a total of 65 students who completed both tests. The test contained multiple choice and open-ended items. We scored the open-ended items using a rubric designed to evaluate depth of content understanding. Student gains were analyzed using a paired T-test. The preliminary analysis of the scores from the pre and posttests using a paired T- test indicate students made statistically significant gains (p-value of 0.001). Answers to open ended items indicated that we made progress in helping students understand the relationship between genes and proteins (14.3% gain and p-value of 0.00), but students still confused key concepts such as the relationship between genes and chromosomes. We also made progress at incorporating molecular mechanisms into explanations of phenotypes, but students still struggle with incorporating all the levels of biological organization into their explanations. Although students struggled with some content, the gains made in the pre and post tests show that during the enactment of the curriculum, students developed a knowledge base that could allow them to legitimately participate (Lave & Wenger, 1991; Moje, 1997) during classroom discussions.

Participants

The How SIMILAR or DIFFERENT Are We curriculum was enacted in 9th and 10th grade classrooms in two urban high schools in a large Midwest city during the 2005-2006 school year. The high school science coordinator for the district selected the teachers based on teacher availability and interest. Ms. Lewis used the curriculum in two 10th and 11th grade general biology classes. Mr. Kaine enacted the curriculum in five 9th-grade general biology classes. The two participating teachers differed in their experience with the students and taught different grade levels. At the time that the unit was enacted, the 9th-grade teacher Mr. Kaine, had been teaching for approximately 5 years and the 10th-grade teacher, Ms. Lewis, had been teaching for 11 years and taught a higher achieving biology class. Both teachers are Caucasian.

The classrooms were representative of the schools' populations each of which are over 97% African-American. Of the 177 students that used the curriculum, 78 students and their parents agreed to participate in the program by allowing us to videotape them in class and review their class work and tests.

According to the test scores, 11% of students at Kellog High School (where Mr. Kaine taught) performed at proficient levels in mathematics, and 46% reached proficiency in reading. Kellog recorded a 70.0% economically disadvantaged enrollment. Mulane High School (where Ms. Lewis taught) saw 15.5% of its students reach proficiency in mathematics and 55.5% in reading. The economically disadvantaged student enrollment was 42.0% at Mulane.

Methods

Study Limitations

The enactment of the materials was a first attempt enactment, and very little professional development was offered to the teachers. Each teacher met with the curriculum developers and discussed the components and goals of the unit. Although classroom discussions were an important goal of the curriculum, it was given brief coverage during the teacher meetings.

This curriculum had limited interaction with assisting the teachers in developing the social norms that are conducive to project-based classrooms. Accordingly, each teacher in this study had different methods of managing the classroom, different relationships with their students, different beliefs about and experiences with project-based science and discussions, and different levels of content knowledge. Each student and teacher brought different ideas of communication to the classroom, and the development of the curriculum did not consider the discursive confrontations that might occur in the classroom.

Due to the lack of professional development in this study, this study has constraints such as teachers (a) feel pressured to cover content and therefore are hesitant to give up time to a rich discussion, (b) worry about classroom management and discussions ranging off topic or into areas of the science that are unfamiliar (c) do not know how to motivate kids to care about discussing science at high, rich, and deep levels, (d) recognize their students do not know enough of the science to have rich discussions, and (e) may not know how to ask good questions that are more than just prompts for the "right answer."

Data Collection

Our research group collected data in the spring semester of the 2005-2006 school year. The data consisted of videotapes of classroom enactment, the teacher guide, student guides (student workbooks), pre and posttests, teacher and student feedback, and surveys. For this study, we focused on the videotapes and the teacher guide. The videotapes allowed us to watch the interactions between the teacher and students and document the social context of the discussion. Using the teacher guide, we were able to categorize the discussion supports and make comparisons between the enacted curriculum and the intended curriculum.

To understand the kinds of verbal exchanges that took place in the classroom, we analyzed several portions of discussions. Since videonotes revealed a prevalence of IRE recitation, discussions that were long enough to demonstrate the instructional and interactional discourse patterns were chosen. Subsets of 5 discussions were used for analysis. To analyze each discussion subset, we used a discourse analysis coding scheme

(Nassaji & Wells, 2000; Wells & Mejia-Arauz, 2006) to characterize the discussions, understand participant structures, and identify discussion practices used.

We had limited assistance in videotaping lessons from the unit, and a result, we missed Ms. Lewis's enactment of the first 3 lessons and collected data from the last 2/3 of Ms. Lewis's enactment. To do a discourse analysis of the discussion subsets, we chose lessons at different time periods of the enactment (beginning, middle and end). We analyzed one discussion from the middle and one from the end of Ms. Lewis's enactment, and one lesson from the beginning, middle and end of Mr. Kaine's enactment.

Teacher Guide Analysis: Are the Materials Educative?

This portion of the analysis describes and categorizes the curricular supports intended to promote classroom discussions. We documented whether a rationale for suggested discussions were written in the curriculum materials and whether strategies were given to help the teacher adapt the discussions for different situations. We also documented each lesson and quantified the strategies and rationales present in the materials: such as rationale only (R,0), strategies only (0,S), rationale and strategies (R,S). Here, we were able to systematically document how teachers were being supported in engaging students in discussions (see Appendix A and Table 2 for Dominant Discourse Trends).

Video Analysis: How Were the Materials Enacted?

To understand what enacted discussions looked like, we reviewed 28 videotapes in real time without playback and wrote the equivalent of fieldnotes (Erickson, 1986) paying particular attention to discussions. In this process, we identified overall classroom discourse themes (Strauss & Corbin, 1998) by coding discussions as IRE or non-IRE. During the second round of watching the videotapes, we documented which research-based inquiry practices (see Table 1 for Discussion Practices Table) teachers used in their discussions.

We transcribed the selected discussions verbatim and used discourse analysis (Nassaji & Wells, 2000; Wells & Mejia-Arauz, 2006) to analyze resulting discussion patterns. The analysis of the discussions focused on the structure of the discussions and the function each move contributed to the discussion sequence (See Appendix B and C). From the analysis, the types of questions teachers and students asked, the level of sophistication of the questions, the kinds of responses given by teachers and students, and the kinds of evaluations or follow-ups given by the teachers, and the participation structures were made visible.

Comparison of Teacher Guide and Video

<u>Discussion Practices (what was happening):</u> Table 1 shows important discussion practices and provided a set of criteria for the analysis of the teacher materials and the enactment. We performed a side-by-side comparison of the curricular discussion supports and the videonotes to show the kinds of discussion practices the teachers were using during discussions.

<u>Discourse Patterns (who was involved):</u> To understand the kinds of speaking patterns that took place when supports were given, we performed a second comparison between the transcripts and the curricular discussion supports to understand the characteristic discussion patterns.

Findings

In this section, we show the results of our analyses of the following questions:

1: How were whole-class discussions supported in teaching materials that use inquiry instruction? This question addressed the following questions: (a) are rationales and enactment strategies provided for each discussion, and (b) is there a relationship between providing strategies and the presence of IRE discourse patterns?

2: What do teacher/student interactions look like when inquiry-based materials are provided? This question addresses the following questions: (a) what are patterns of teacher/student interactions and (b) what kinds inquiry practices are present during discussions?

How were whole class discussions supported in the teaching materials that use inquiry instruction?

<u>Are rationales and enactment strategies provided for each discussion?</u> We report a documentation of our analysis of curricular supports for discussions and the resulting discourse patterns for each discussion for both teachers (See Appendix A). The curriculum materials encouraged the teachers to engage the students in discussions on 36 different occasions. Of the 28 videotapes, 16 discussions were captured (Ms. Lewis had 6 and Mr. Kaine had 10). Table 2 documents the frequency of suggested discussions and whether a rationale and strategies were provided based on videotape data. The presence of IRE discourse patterns for each videotaped discussion is also documented in Table 2.

Table 2 shows a comparison between the curriculum supports and the enacted discourse patterns. Out of 36 discussions, 13 (36.1%) rationales were given and 11 (30.6%) adapt and use strategies were given. There were 7 instances where rationale and enactment strategies were given together (19.4%). The remaining 5 discussions were not supported at all.

Is there a relationship between providing strategies and the presence of IRE discourse patterns? Although the interactional and instructional discourse pattern remained IRE/F and teacher centered, 2 out of 7 instances where teachers were given rationale and enactment strategies together, teacher-student interactions increased, with teachers using follow-up questions and guiding students towards scientific discourse, and students putting forth and revising ideas. (see Table 2: Mr. Kaine Lesson 5 Discussion 2 and Ms. Lewis Lesson 5 Discussion 5). For example, in Lesson 5, Discussion 2, the teacher guide suggested a discussion about the genetics of fly eyes. Within the materials, the rationale explained that the discussion was meant to uncover students ideas. The materials also said that the discussion can be used as a formative assessment. The enactment strategy was to use follow-up questions where teachers would ask the students to elaborate and/or explain their answers. In the enacted discussion, Mr. Kaine used the suggested strategies and students used more explanations to support their ideas when prompted by the teacher. His enactment showed less IRE structured discussions and more student speaking turns and sharing of ideas.

Similarly, in Lesson 5 Discussion 5, where teachers facilitated an ethical discussion, the curriculum materials supported the teacher by explaining the rationale for the activity and suggesting a scaffold to help the students organize different aspects of ethical discussions. The rationale was stated to help students understand the kinds of questions that society faces and how to make decisions regarding questions of morality. The materials suggested a scaffold that identifies specific aspects of ethical decision-making. In Ms. Lewis's enactment, she used follow-up questions to promote student response elaboration. She also provided students with a metascript to help students keep their thinking focused on the content. Ms. Lewis's enactment had characteristics of dialogic discussions. Like Mr. Kaine's discussion above, students in Ms. Lewis's classroom shared their ideas, expanded their responses and shifted attention away from the teacher and onto the students.

The comparison of the curricular supports and the enacted discussions indicated that a combination of rationale and enactment strategies helped promote student involvement and explanation, yet IRE discussions were still prevalent. Although suggested strategies were enacted, video data showed that the structure of many discussions remained monologic, a recitation of answers, and teacher centered. The data shows, though, that a rationale and strategy combination may be a starting point for supporting teachers in enacting inquiry-based discussions in the classroom.

What do teacher/student interactions look like when inquiry-based materials are provided?

What are patterns of teacher/student interactions? Although project-based learning environments place an emphasis on inquiry-based communication skills, our results demonstrate that teachers struggled to sustain discussions, engage dialogic interactions, and limit their centrality to the discussion. In Table 2, many teacher and student interactions followed the IRE/F recitation pattern and a majority of interactions were monologic. The students did not address each other to ask for or provide additional information or confront each others' ideas. In most cases, the teachers led the discussions and inserted evaluative comments of student responses.

The following excerpts show the interactional patterns that occurred between teachers and students during discussions. We also used Table 1 as a guide for inquiry-based discussion practices documentation.

Mr. Kaine

IRE recitation was the most prevalent discourse pattern in Mr. Kaine's discussions. Although he attempted to ask high level questions and use follow-up questions, he eventually gave evaluations to student responses and elaborated the answers for the student. Many times, students gave one-word responses and Mr. Kaine accepted them as complete answers. Students were not asked to explain their thoughts nor the mechanisms behind their answers. The following excerpt is part of a discussion about sickle cell disease (see Table 2: Lesson 4, Discussion 1). This discussion was not supported with a rationale or enactment strategies. The teacher asked the students questions regarding a video that they watched the day before. In this excerpt, the teacher asked a question, a student provided an answer, and the teacher evaluated and extended the response for the student (See Appendix B for discourse analysis of excerpt).

Mr. Kaine: Now we look deeper, we look at the level of the protein. What do we see happening inside the cell to hemoglobin protein? What’s it doing?

Grace: Multiplying? Dividing?

Mr. Kaine: Its not that there is more hemoglobin. It’s just that the hemoglobin is, has a different shape right? Its not normal hemoglobin, its mutant hemoglobin. So, you can say that, if you look at the level of protein, there is one amino acid that’s different. You all saw that in the last figure. Right, right here? [Points to powerpoint] One amino acid change causes the change in the shape of the hemoglobin, a small difference. And then its starts doing this. Right? A small change in the shape and it starts glomming together to make crystals. So, how would we say that? Very simply, just the hemoglobin is different from normal hemoglobin. A different shape.

Gary: Cuz of the amino acids?

Mr. Kaine: Because of that one amino acid difference. I think that would be perfect. If you write down that there is one amino acid difference in the hemoglobin protein, it’s a mutant form of it and it doesn’t work exactly right, that would be your explanation at the level of the protein.

In dialogic discussions, participation is not necessarily a linear progression of questions and answers, however, in the above sequence, every interaction was a linear exchange between the teacher and students. The structure of participation was: teacher initiates a question, student responds, teacher evaluates. Instances where the teacher used follow-up questions, resulted in evaluative feedback, providing the student with an “accept” or “reject.” Few students were given opportunities to share their knowledge, unless the initial response was incorrect, or if the teacher specifically asked for a different student.

In the sequence above, Mr. Kaine started with an initiation question that required an explanation of the cause and process of protein mutations. Asking the students “What do we see happening… What is it doing?” (lines 1 and 2), suggests that the students should provide a mechanism for a change in protein shape to cause the awkward sickle cell shape. Instead, Grace, the first student, provided a one-word response, and Mr. Kaine rejected the response and explained the protein shape for her. Mr. Kaine used his speaking turn to provide an extended and elaborated explanation for what was happening at the protein level and did not encourage the students to contribute to the discussion or initiate questions.

The excerpt also shows a large difference in speaking lengths between the teacher and the students. Mr. Kaine’s speaking turns were much longer than the students and were dominant in the discussion (lines 4-11 and 13-16). Student responses were not only very short and consisted of a few words (lines 3 and 12), but were also indirect responses. Rather than providing direct responses to Mr. Kaine’s questions, students replied with additional questions as answers, often contradicting each other (line 3). Because students understood that Mr. Kaine would not only evaluate their responses, but also provide the correct responses without follow-up, students did not attempt to formulate correct explanations for themselves. Instead, students participated in the IRE pattern by waiting for Mr. Kaine to provide an evaluation of their responses. As the excerpt shows, students shouted out guesses and questions and waited for Mr. Kaine to provide an evaluation and the correct information.

Discourse analysis shows that the interactional and instructional discourse patterns maintained the IRE recitation structure. Earlier we mentioned that a combination of rationale and strategies might be a starting place for supporting teachers in dialogic discussions, yet Table 2: Lesson 4, Discussion 1 shows that there was no rationale nor enactment strategies to support the teacher while enacting this discussion. Our results show that Mr. Kaine repeatedly engaged in IRE recitation and monologic interactions, which is consistent with the infrequent curricular supports.

Ms. Lewis

Discussions in Ms. Lewis' classroom also took the IRE/F Discourse pattern. Her instruction also included a combination of non-evaluative and evaluative follow-ups to student responses. In many cases, Ms. Lewis asked a series of follow-up questions as a way to guide students to higher order "Why" or "How" questions (see Appendix C for discourse analysis). Although the following discussion pattern was still IRE, the excerpt shows Ms. Lewis asking follow-up questions to lead the students to the higher level questions. This discussion followed a DNA building activity, where students constructed DNA models in groups, and a video. This discussion excerpt came from Lesson 3, Discussion 2 and was supported with a rationale and no enactment strategies.

Ms. Lewis: Ok. So, if you got blue, what do you know about some other parts of the DNA? Do you know what’s going to be above or below blue necessarily?
Class: No.
Ms. Lewis: No, not necessarily. But what do you know?
Effie: What will be across from it. That it won’t be an orange or another blue?
Ms. Lewis: What’s always across from blue?
Class: (answers vary) Orange; green.
Ms. Lewis: Orange. Why?
Class: (Answers vary)
Theo: Opposites attract.
Ms. Lewis: So, you think they are opposites? Ok, do me a favor. Open your books to page 5, lesson 3.

The initiation question that started this discussion was, “When you look at your [DNA] model, what kinds of relationships do you see happening between these parts? If you look at the bases going down the middle, is there any kind of pattern that you see?” This initial nuclear exchange began with a high-level cognitive question that required the students to use their experience with the DNA activity, to form patterns and explanations.

Similar to Mr. Kaine’s discussion, the discourse pattern followed teacher-student-teacher. What makes this discussion different from Mr. Kaine’s is Ms. Lewis’s use of follow-up questions. In the above excerpt, Ms. Lewis asked questions related to the questions in line 1 and 2, changing the pattern from IRE to IRF and moving closer to dialogic discourse (see lines 4, 6, and 8). As discussed earlier, dialogic discussions require students to put forth ideas, use evidence and explanations, rather than one word responses. Ms. Lewis attempted to elicit student use of evidence and explanations by asking questions like “What do you know?” (line 4) and “Why” (line 8). Although these teacher moves are meant to increase student participation and cognitive involvement in the discussion, Ms. Lewis’s students continues to change the discussion pattern to IRE by providing one-word responses that appear to be guesses.

In addition, the excerpt shows that students did not address each other or respond to each other, and instead continued to respond to the teacher. As in Mr. Kaine’s excerpt, Ms. Lewis was the at the center of the discussion, providing all feedback and validation to the students.

Table 2 (Lesson 3, Discussion 2) shows that a rationale, and no enactment strategies were given to support this discussion. Ms. Lewis struggled to engage the students in the discussion, and the few supports gave her no suggestions for how to motivate students to elaborate their responses or include multiple students in the discussion. As result, Ms. Lewis repeatedly searched for questions to promote student explanations and elaborations. However, students replied with guesses and one-word responses. Although Ms. Lewis's discussions used follow-up questions and followed an IRF pattern, supports from the curriculum did not assist Ms. Lewis with student involvement and participation. As Ms. Lewis's students continued to incorrectly respond to her questions, Ms. Lewis ran out of strategies and asked students to reference the textbook. In her attempt to refrain from being the source of knowledge, she shifted the knowledge authority to the textbook, rather than to the students.

<u>How do the discussions encompass inquiry practices of discussions?</u> To document the frequency of inquiry discussion practices the teachers used during classroom discussions, we quantified the number of practices used and how often they were used by watching videotapes and calculating the number of discussion practices per discussion in every lesson (see Table 3). Table 3 shows that the teachers incorporated inquiry-based practices into discussions, but discourse analysis of the discussions shows that many of those practices did not include student participation. For example, one inquiry practice is helping student by working at the intersection of scientific and everyday language (Magnusson et al., 2004). This might include revoicing (O'Conner & Michaels, 1993) student responses, or providing a metascript (Magnusson et al., 2004) for the students . Refer to Lesson 1 in Table 3. In this lesson, 65% of the inquiry-based discussion

practices in Mr. Kaine's enactment were teacher revoicing and providing metascript. Although this practice is a useful and beneficial part of science discussions, student participation, which helps legitimize student membership in the scientific community, is absent in the observed enacted discussions.

According to Table 3, teachers used several inquiry practices, but many of the practices did not include student action. Discourse analysis shows that discussions often started with inquiry practices, such as asking negotiating questions, but often resulted in a series of evaluative feedback and teacher explanations (see Mr. Kaine and Ms. Lewis discussion excerpts.) Our analyses show that in 36 discussion opportunities, teacher participation was the focus of many discussions. In Table 3, the use of inquiry-based discussion practices used by Mr. Kaine and Ms. Lewis involved teacher actions more frequently than student action.

Discussion

Summary of Results

The goal of this study was to compare the curricular supports with the discussion enactment and show the resulting discursive practices in two High School science classrooms that engaged in project-based science instruction. We aimed to understand what kinds of discussions took place when supports were embedded in curriculum materials. Through a comparison of the curriculum materials and teacher enactment, we found both teachers followed the curriculum materials closely by adhering to the activities, suggested discussions and provided supports, yet IRE recitation remained the dominant discourse pattern.

After our analysis of the curriculum materials, we speculated on why IRE continued to dominate science discussions. We found five potential reasons. First, the curriculum materials had few and inconsistent supports (see Table 2). Our study showed that we did not provide adequate supports to help teachers with enactment. Some of our evidence also showed that when supports are present, teachers realized and enacted opportunities for discussion.

Second, it is possible that the curriculum materials can constrain teacher enactment. With new content and instructional practices, teachers may have closely depended on the curriculum materials to guide their teaching; which may have inadvertently constrained their enactment. The subject matter of genetics and genomics in curriculum is new science that is still being developed in the field, and teachers may have had difficulty adapting their practice to meet the unfamiliar content. Due to the unfamiliar content, teachers may want to maintain control of the classroom for fear of discussions ranging off topic or into areas of science that are foreign or controversial (Alvermann, O'Brien, & Dillon, 1990; Kelly, 1986). Furthermore, student may have also struggled to learn and adopt different scientific ways of communication and reverted to the familiar IRE.

Third, educative curriculum materials are not enough. As the literature shows, discussions in science are very complex and multifaceted. Simply providing teachers with a list of suggestions may not be enough. We hoped that when teachers used the strategies, then discussions would be more dialogic, but we were mistaken. Our results showed 2 out of 7 discussions supported with a rationale and enactment strategies as dialogic. In other enacted discussions, teachers used the strategies and discussion practices, but the discourse pattern of the discussions remained IRE.

Fourth, we do not know which strategies promoted discussions better than others. The data showed that when discussions were supported with a rational and enactment strategies, there were chances for dialogic discussions. However, we do not know whether the dialogic discussions were a product of the supports or simply easier to enact. If it was due to the supports, which supports were affective? If supports did not contribute to the discussion, what did the teacher do to enhance the progression of the discussion?

Finally, we did not help teachers include *student* participation in this new discussion format? Students have been enculturated into IRE recitation patterns of discussion and find it difficult to welcome dialogic interaction. Attempting to modify how teachers communicate with their students is changing the culture of the classroom and may conflict with the teachers' and students' beliefs, experiences, and intuitions regarding discussions (Alvermann & Hayes, 1989). We did not explicitly help teachers create a learning environment that supported inquiry-based discussions.

Thinking Differently About Curriculum Development

If one goal of project-based science is to encourage dialogic discussions in the classroom, then curriculum development may look quite different from what is currently practiced. Standards stress the promotion of communication, argumentation and science literacy (American Association for the Advancement of Science, 1993; National Research Council (NRC), 2000) and some curriculum materials address them by providing teachers with prompts. This may be effective, but I ask, does excluding teachers from the development process resemble IRE? Is this sort of curriculum development similar to transmission models of learning? Does that complicate and/or compromise the goals of constructivism (Krajcik & Blumenfeld, 2006), dialogic interactions (Wells & Mejia-Arauz, 2006), and the development of Discourse literacy (Gee, 1996)? I further ask, is it possible that the authority of the curriculum supercedes the teachers' authority in teaching science more dialogically? In other words, might excluding teachers from curriculum development constrain the teachers practice? Perhaps teachers bring social and discourse knowledge to the table that is not being considered by the curriculum.

In the analysis of the curriculum, we thought that consistent and systematic support would help create opportunities for dialogic discussions in the classroom. But we found that even with supports, IRE was prevalent. Although the literature shows that educative curriculum materials are a necessary component of teacher enactment, this study shows that classroom discussions are more complex than we thought.

In order to meet the complex needs of dialogic discussions, it might be beneficial to create curriculum materials that would compliment and/or mimic the dialogic inquiry model of the science curriculum. We refer to Ball and Cohen's (1996) suggestion that the design of reform-based curriculum materials, in this case, project-based curriculum materials, should be more closely tied with practicing teachers so that teachers can construct their own understanding of the process of discussion and their knowledge and learning processes can be taken into account during curriculum development and enactment (Putnam & Borko, 2000). This would distribute some of the expertise necessary for project-based teaching to one of the tools used by teachers while situating that expertise within the teachers daily practice. Using the same constructivist learning theory that is used for student learning during the development of project–based curriculum materials might promote teacher learning of dialogic discussions. We certainly have no complete and final solutions to such a massive matter, but think it is an area that should be explored in more depth.

In future studies, we plan to extend the present study and consistently use a combination of rationale and enactment strategies as embedded educative features in revised curriculum materials. This will be a starting point for an intensive collaboration process with a focus group of teachers to create curriculum materials that support teachers in classroom science discussions. We will explore methods of professional development that encourage and support teachers in becoming more reflective learners in the process of inquiry-based discussions.

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Tables

Table 1: Discussion Practices Table. Four categories of inquiry-based discussions based on a collection of research studies.

Discussion practices	**Description**
1. Making knowledge explicit	1. How do students use evidence and scientific reasoning to support claims?
2. Asking questions and providing non-evaluative follow-ups.	2A. How do teacher questions incorporate student reflection, negotiation, use of claim, evidence, reasoning and the confrontation of prior knowledge? 2B. How does the teacher extend the discussion with follow-up questions?
3. Supporting student communication.	3A. What roles did students play during discussions? 3B. What type of public document did the teacher provide to keep track of the goals and points made?
4. Discussion etiquette	What kinds of classroom norms are established in the class concerning discussions? 4A. Teacher as facilitator and manager of discussion 4B. Teacher works at intersection of everyday language and scientific discourse (metascript, revoicing, collective memory, seeding, restating driving question, and using prompts. 4C. Differential response for appropriate uses of language and actions.

Table 2: Dominant Discourse Trends. Both classroom discussions generally demonstrated the IRE/F instructional and interactional pattern. There were a total of 16 video recorded discussions. Each discussion in each lesson, is categorized as either monologic (Mo), having the IRE/F recitation, or moving towards dialogic (~Di), displaying intersubjectivity. The use of inquiry-based discussion practices is also documented (*). R denotes a provided rationale. S denotes provided strategies. 0 denotes no educative curriculum materials provided.

Lesson	1 R,S	1 R,S	1 R,S	1 0,0	2A 0,0	2B 0,0	3 R,0	3 R,0	3 R, 0	4 0,0	5 R,S	6 0,0
Discussion	1	2	3	5	4	2	4	2	3	1	2	2
Mr. Kaine	Mo	Mo	Mo	Mo	~Di	Mo	Mo	~Di	n/a	Mo	~Di	n/a
	IRE *	IRE *	IRE *	IRE/F *	IRE/ F	IR E	IRE	IRE/ F*	No D	IRE/F *	IRE/F *	No D

Lesson	3 R,0	3 R,0	5 R,S	5 R,S	6 0,0	6 R,S
Discussion	2	3	2	5	1	2
Ms. Lewis	~Di	Mo	Mo	~Di	n/a	n/a
	IRF*	IRE/Lect	IRE*	IRF*	No D	No D

Table 3: Frequency of Inquiry-Based Discussion Practices per Discussion.

Average frequency of discussion practices per discussion (dp/D) in each videotaped lesson. The percentage shows the frequency of non-student participation (nonSs) inquiry practices.

	1	2A	2B	3	4	5	6
Mr. Kaine	7 dp/D 65% nonSs	2 dp/D 66% nonSs	5 dp/D 70% nonSs	6 dp/D 83% nonSs	9 dp/D 58% nonSs	4 dp/D 76% nonSs	6 dp/D 75% nonSs
Ms. Lewis	X	X	X	4 dp/D 52% nonSs	X	5 dp/D 50% nonSs	7 dp/L 65% nonSs

Appendix A

Summary of Educative Features for All Videotaped Discussions: We provide a holistic view of curricular supports and resulting teacher enactment. For each lesson in the curriculum (column 1), the amount of suggested curricular discussions is documented (column 2). For each discussion, we describe the embedded curricular support was provided (column 3), whether a rationale was present (column 4), and whether strategies for the discussion were provided (column 5). After watching videos of enactment, we documented discourse patterns and the use of inquiry practices for Ms. Lewis (column 6) and Mr. Kaine (column 7).

Ls	Total Disc	Features	Rationale	Suggested Adaptation Strategies	Discourse Patterns Ms. Lewis	Discourse Patterns Mr. Kaine
1	5	1. Provides the points to be made in the disc. (PTM)- discuss similarities and differences	1. Yes- Gives the point of the activity	1. Yes- Chart, follow-up questions,	No Tape	Uses IRE recitation but incorporates inquiry-based feature- chart. Was more of a sharing session.
		2. PTM- similarities and differences around the world	2. Yes- Gives the point of the activity	2. Yes- Chart, follow-up questions,	No Tape	Uses IRE recitation but incorporates inquiry-based feature- chart. More of a sharing session.
		3PTM- similarities and differences between species	3.Yes- Gives the point of the activity	3. Yes- Chart	No Tape	Uses IRE recitation but incorporates inquiry-based feature- chart. More of a sharing session.
		4. PTM- Main idea- biological differences	4. Yes- Gives purpose of activity	4. No	No Tape	No Tape
		5. PTM- report student results about diff skin types	5. No	5. No	No Tape	IRE/F. Uses follow-up questions.
2A	3	1. PTM- Structure of amino acids	1. Yes- Gives purpose of activity	1. No	No Tape	No Tape
		2. PTM- Toober activity (general protein); discussion on protein shape	2. No	2. No	No Tape	IRE reciation. Students answered in unison to teacher's questions.
		3. PTM- Toober activity on Lysozyme; discussion on protein shape	3. No	3. No	No Tape	No Tape
2B	4	1. Points to make- discuss work of a cell	1. No	1. Yes- public document suggestion: chart	No Tape	No Tape

		2. PTM- discuss work of a cell	2. No	2. Yes- public doc: chart	No Tape	No Tape
		3. PTM- discuss images and animations on proteins	3. No	3. No	No Tape	No Tape
		4. PTM- Protein examples in species guides	4. No	4. No	No Tape	IRE/F and lecture. Teacher asked students for elaboration.
3	9	1. PTM- Prior knowledge about DNA; expose misconceptions	1. No	1. No	No Tape	No Tape
		2. PTM- DNA model	2. Yes- Goal of activity	2. No	Watch video about DNA and build models. IRF Discussion: More monologic, but students elaborate responses.	Watch video about DNA then IRE recitation about video and DNA models.
		3. PTM- Cookbook analogy	3. Yes	3. No	More or a recitation. Teacher explains how genes are like a recipe. No discussions actually happened.	IRE/F- students had more opportunities to explain their answers.
		4. PTM- diagram of protein synthesis of LDL receptor	4. Yes- vague	4. No	No Tape	No discussion. Students worked from their student guides.
		5. PTM- mutations in people with FH	5. No	5. No	No Tape	No Tape
		6. PTM- Mutations are root of variation in DNA	6. No	6. No	No Tape	No Tape
		7. No PTM- FH Reading	7. No	7. No	No Tape	No Tape
		8. PTM- diff btwn diseased and healthy people	8. No	8. Yes- have student make a list	No Tape	No Tape
		9. PTM- Recipes are instructions	9. No	9. No	No Tape	No Tape
4	4	1. PTM- look at sickle cell under microscope	1. No	1. No	No Tape	IRE/F and lecture

		2. PTM- Sickle cell Toober activity	2. No	2. No	No Tape	No Tape
		3. PTM- DNA can pass on mutations	3. Yes	3. No	No Tape	No Tape
		4. No PTM- Predict who will get sickle cell	4. No	4. No	No Tape	No Tape
5	5	1. PTM- Review past lessons and the driving question.	1. Yes- vague	1. No	No Tape	
		2. PTM- why fly eye colors are different Did not explicitly say to have a discussion	2. Yes .	2. Yes- Ask for hypotheses and explanation	Students shared their explanations and hypotheses, rather than discussed them. IRE structured sharing while using inquiry-based practices.	Teacher lectures and invites students to respond. Mainly IRE/F. Encouraged students to answer questions and explain their answers.
		3. PTM- why do people have albinism	3. No	3. Yes- Ask for hypotheses	No Tape	No Tape
		4. PTM- activity about 2 people with albinism- mutations in DNA	4. No	4. No	No Tape	No Tape
		5. Ethical discussion- Myostatin	5. Yes	5. Yes- Cognitive scaffold for discussion	Students and teachers engaged in an ethical discussions. Teacher incorporates many inquiry-based discussion practices.	No Tape
6	6	1. No PTM- Discuss findings of DNA percentage in similarity activity	1. No	1. No	Students make calculations without discussion.	No Tape
		2. No PTM- DNA Scavenger hunt activity results	2. No	2. No	Students do the scavenger hunt without discussion	Students do the scavenger hunt without discussion
		3. Ethical discussion dilemmas- genetic engineering or genetic	3. Yes	3. Yes- Cognitive Scaffold	No Tape	No Tape

		screening				
		4. No PTM- discuss driving question	4. Yes	4. Yes- provide evidence	No Tape	No Tape
		5. PTM- Environment_ Identical twins	5. Yes	5. No	No Tape	No Tape
		6. PTM- Extension discussion: Clones and environment	6. No	6. No	No Tape	No Tape

Appendix B

Applied Coding Scheme: Mr. Kaine Discussion Excerpt. We show the discourse analysis of Mr. Kaine’s classroom discussion on Sickle Cell.

Sequences	Discussion	Exchange Type	Move	Function
Sequence #1	1. Mr. Kaine: Now we look deeper, we look at the level of the protein. What do we see happening inside the cell to hemoglobin protein? What’s it doing?	Nuclear exchange	Initiation	Question. Starts a new exchange. New question. This is a process question. High order- analysis/explanation.
	2. Grace: Multiplying? Dividing?		Response	Fact response that acknowledges the question. [Guessing?]
	3. Mr. Kaine: Its not that there is more hemoglobin. It’s just that the hemoglobin is, has a different shape right? Its not normal hemoglobin, its mutant hemoglobin.		Evaulation	Rejection with justification- Low level.
	4. Mr. Kaine: So, you can say that, if you look at the level of protein, there is one amino acid that’s different. You all saw that in the last figure. Right, right here? (Points to powerpoint) One amino acid change causes the change in the shape of the hemoglobin, a small difference. And then its starts doing this. Right? A small change in the shape and it starts glomming together to make crystals.			Gives the answer for student.
	5. Mr. Kaine: So, how would we say that? Very simply, just the hemoglobin is different from normal hemoglobin. A different	Dependent Exchange	Follow-up	Conventional explanation question. Give- asks another sequential question. Then answers it himself.

	shape.			
	6. Gary: Cuz of the amino acids?	Embedded Exchange	Response	Request clarification
	7. Mr Kaine: Because of that one amino acid difference.		Follow-up	Gives clarification
	8. I think that would be perfect. If you write down that there is one amino acid difference in the hemoglobin protein, it's a mutant form of it and it doesn't work exactly right, that would be your explanation at the level of the protein.		Follow-up	Answers the question for the student. Also provides elaboration and explanation for student. Tells the students what to write down.
Sequence #2	9. Mr Kaine: The next question is, what causes there to be a different protein? What is it that determines what the protein is going to be?	Nuclear exchange	Initiation	Question. Conventional explanation question. High level.
	10. Michael: DNA?		Response	Fact that acknowledges the question.
	11. Mr Kaine: The DNA.		Evaluation	Accept. Low Level.
	12. Mr. Kaine: So, what should we write at the DNA level?	Dependent exchange	Follow-up	Question
	13. Michael: A change.		Response	Fact- Acknowledge Question
	14. Mr Kaine: A change.		Evaluation	Accept. Low level
	15. What kind of change is it? You told me-	Dependent Exchange	Follow-up	Demand Question
	16. Student: -A substitution.		Response	Fact- Acknowledge Q
	17. Mr Kaine: Yep, you told me what kind of substitution. You said it was a mutation and that it was a substitution mutation.			Continues explanation

	18. Mr. Kaine: So, folks what you can write for the last one, gene or DNA level, you can say the gene has changed. That there is one letter that’s different. It’s a substitution mutation. And that’s what causes the protein to be different. Don’t forget that genes are the instructions for how to make a protein.		Follow-up	Gives answer for students. Tells students what to write.

Appendix C

Applied Coding Scheme: Ms. Lewis Discussion Excerpt. We show the discourse analysis of Ms. Lewis's classroom discussion on DNA structure.

Sequences	Discussion	Exchange Type	Move	Function
Sequence #1	1. Ms Lewis: Ok. So, if you got blue, what do you know about some other parts of the DNA? Do you know what's going to be above or below blue necessarily?	Dependent Exchange	Initiating question	Rephrase of initial question from nuclear exchange- simplifies the question. Low-level recall question.
	2. Class: No.		Response	Fact response acknowledges
	3. Ms Lewis: No, not necessarily. But what do you know?		Evaluate and Follow-up	Give: T wants more from students
	4. Effie: What will be across from it. That it won't be an orange or another blue?		Response	Fact- Acknowledges Q
	5. Ms Lewis: What's always across from blue?		Follow-up	Give
	6. Class: (answers vary) Orange; green.		Response	Fact- Ack Q
	7. Ms Lewis: Orange. Why?		Follow-up	Demand
	8. Class: (Answers vary)		Response	Answer
	9. Theo: opposites attract.		Response	Fact-Ack Q
	10. Ms Lewis: So, you think they are opposites? Ok, do me a favor. Open your books to page 5, lesson 3.		Follow-up	Null evaluation/ Acknowledge
	11. Alright, you see that model of DNA?	Dependent Exchange	Initiation	Question
	12. Class: Yes.		Response	Fact- Ack Q
	13. Ms. Lewis: You see how Cs and Gs are always across from each other and As and Ts are always across from each other?		Follow-up	Give
	14. Class: Mmhmm.		Response	Acknowledge
	15. Ms. Lewis: Why? Why do you think they partner up in that way?		Follow-up	Conventional explanation question