DOCUMENT RESUME

ED 407 254 SE 060 186

AUTHOR Flick, Lawrence B.; Dickinson, Valarie L.
TITLE Teacher Intentions, Teaching Practice, and Student Perceptions of Inquiry-Oriented Teaching.
PUB DATE 22 Mar 97
NOTE 45p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (Oak Brook, IL, March 21-24, 1997).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Case Studies; *Constructivism (Learning); *Discourse Analysis; *Discovery Learning; *Educational Strategies; *Inquiry; Intermediate Grades; Middle Schools; Science Instruction; Secondary Education; Student Attitudes; Thinking Skills

ABSTRACT

This study takes a holistic perspective towards inquiry teaching by examining the alignment among teacher intentions, teaching practices, and student perceptions of teaching practices. The first part of the study examines the alignment between teacher intentions for instruction and classroom teaching practices. The second part of the study examines the alignment between teaching practices and student perception of teaching practice. Data for this study were obtained from a National Science Foundation project entitled "Integrated Science Concepts" (ISC) that presented constructivist teaching strategies, elements of the nature of science, and integrated thematic concepts in science to middle level and high school teachers. The questions addressed by the research pertain to the alignment of teacher intentions with teacher achievements, and the alignment of student perspectives with teacher intentions and observed teaching behaviors. The results are presented in a series of case studies that are discussed and compared with regard to the research questions. Contains 21 references. (DDR)

Teacher Intentions, Teaching Practice, and Student Perceptions of Inquiry-Oriented Teaching

by

Lawrence B. Flick

Valarie L. Dickinson

Paper Presented at the Annual Meeting
of the National Association for Research in Science Teaching
Oak Brook, Illinois
March 21-24, 1997

Teacher Intentions, Teaching Practice, and Student Perceptions of Inquiry-Oriented Teaching

Lawrence B. Flick
Valarie L. Dickinson
Oregon State University

Problem

Initiating, conducting, and maintaining a sense of inquiry as a part of instruction in science is a highly complex form of teaching. Understanding the nature of this kind, or better said, these kinds of instruction, is a major implication of the National Science Standards (NRC, 1996). Just as the professional pursuit of science knowledge is multi-faceted, both plodding and imaginative, the nature of inquiry-oriented teaching is multi-faceted. Inquiry-oriented instruction is direct and informative as well as innovative and generative. The teacher is constantly adjusting instruction to accommodate students, materials, space, and time. Research studies attempting to understand this form of instruction have been relatively silent on the actions of the teacher. Observations have focused heavily on students and materials. Researchers have examined instructional processes in terms of parts and in terms of a whole. Studies of parts have examined design of materials (Anderson & Roth, 1989), structure of long-term projects (Crawford, 1996), classroom tasks (Sanford, 1987), open-ended inquiry (Roth, 1994), and grouping of students (Carter & Jones, 1994). Studies taking a holistic perspective of inquiry teaching have provided more information about the teacher's role by examining metaphors or mind frames of teachers (Tobin, Kahle, & Fraser, 1990) and teacher understanding of inquiry teaching models (Flick, 1996).

This study has focused on middle level classrooms. The greatest decline in attitudes toward science comes between grades 6 and 7 for males, females and blacks (James & Smith, 1985). At the middle level, science has become a separately graded subject. Its abstract and often counter-intuitive content puts stress on newly developing cognitive skills and often poorly developed study habits. The nature of this new subject may not be presented in a way that is very appealing to students who are

beginning to examine their world with new eyes looking out from a rapidly developing body and new, untested, social skills. Adolescents are beginning to think in abstract terms that can consider more than one dimension of a problem but often require concrete reference points (Keating, 1990). A better understanding of science instruction in middle level classrooms is crucial for designing instruction that maintains student participation in science so that they don't limit their options in high school (Carnegie Foundation, 1995; Kelly, 1987).

This study took a holistic perspective of inquiry teaching by examining the alignment among teacher intentions, teaching practices, and student perceptions of teaching practices. The first part of the study examined alignment between teacher intentions for instruction and classroom teaching practices. The second part of the study examined alignment between teaching practices and student perception of teaching practice. The study is based on data collected from teachers participating in an NSF project, Integrated Science Concepts (ISC), that presented constructivist teaching strategies, elements of the nature of science, and integrated, thematic concepts in science to elementary and middle level teachers.

For the purposes of this study, the notion of constructivist-based teaching practices and inquiry-oriented teaching practices have been conflated. The two terms were used more or less interchangeably during ISC workshops and teachers used them interchangeably during interviews for this study. Discussion of inquiry in the National Science Education Standards (NRC, 1996) includes many references to teaching practices that are consistent with constructivist-based pedagogy. A type of inquiry teaching that prompts student thinking in terms of current ideas and promotes safe, free expression of those ideas is consistent with the developmental needs of early adolescent students (Keating, 1990). The term "inquiry-oriented teaching" will be used to refer to this form of inquiry teaching throughout this paper.

Specific research questions were:

1. Are teacher intentions for instruction valid representations of recommended classroom practice presented in ISC workshops?
2. Do live and video tape observations of teaching practice align with teacher's verbalized intentions?
3. Are student interpretations of teaching practice aligned with teacher intentions?
4. Are student interpretations of teaching practice aligned with observed teaching behavior?

Subjects

Three middle level teachers and one fifth grade teacher were selected from a total of eight teachers participating in ISC who taught either middle level or fifth grade. Fifth grade teachers were included in the study to increase the number of teachers from which to choose. We also thought that a classroom on the entry side of the transition to middle level might offer another interesting contrast. Teacher selection was based on criteria derived from observations of teachers during ISC workshops, from lesson plans and journals required by the project, and from video tapes of classroom teaching taken prior to the start of the program. These data were used to select teachers who represented different teaching skills with respect to the inquiry-oriented objectives of ISC (see Table 1).

Teachers were given the Classroom Learning Environment Survey (CLES) (Taylor, Fraser, White, 1994) and the Science Teacher Efficacy and Beliefs Inventory (Enochs & Riggs, 1990) prior to the start of the ISC program. Table 2 compares the scores of the four study teachers with the average scores of the four who were not selected.

Methods

The questions this study proposes to answer are made complex by being rooted in the thoughts of teachers and students operating in real classrooms. Semi-structured interviews and classroom observations using high inference techniques have been used to create four case studies. The cases are described through the words of the teachers, the words of their students, and the reflections and synthesis of the authors. Insights into the practice of inquiry-oriented instruction have been derived from both individual cases and from ad hoc comparisons across cases. The results of this study can be used to raise new questions and propose study techniques that seek more precise connections among factors that constitute the complex learning environments of inquiry-oriented classrooms.

Each teacher was interviewed using a protocol based on segments of the CLES and the STEBI (see Fig. 1). The first author designed the protocol to allow teachers to characterize their classroom instruction and to elicit their intentions for the unit of instruction observed for this study. Segments of the CLES and STEBI that most closely matched the content of ISC workshops were selected as design parameters. Content validity of the protocol was independently assessed by the second author. The second author was very familiar with the content of the workshops as well as the CLES and STEBI. It was noted that the segment of the CLES concerning science

learning outside the classroom, "Learning about the World," was omitted from the protocol. While it was a relevant part of the ISC workshops, this study focused on classroom practices and student perceptions. To some extent, teacher views related to learning science outside the classroom were covered by other parts of the protocol, for instance, the questions on expression of ideas (see Fig. 1). The interviews lasted between 45 minutes and to an hour. These interview data were also used to establish teacher intentions for specific inquiry-oriented teaching practices as well as to assess their interpretations of practices recommended in ISC workshops. The reliability of the protocol was assessed by successively comparing responses across teachers. There were no major variations in how teachers responded to the questions. Had there been a problem with teacher interpretation detected in the responses, previously interviewed teachers would have been contacted to double check their interpretations.

Partial transcription and field notes of two video taped class sessions and two visits to each classroom provided data on actual teaching practices. All of the classroom observations occurred during the teaching of a single unit that was derived from a topic or theme in the ISC workshops (see Table 1). Teachers were to employ inquiry strategies modeled and discussed in ISC workshops during the teaching of this unit. Field notes were compared to interview protocols to assess alignment between implemented teaching practices and teacher intentions.

Students were interviewed to assess student perspectives of teaching practice. Teachers were asked to select approximately six students for interviewing based on the criteria of providing a cross section of conceptual understanding of the science subject matter and an even distribution between males and females. Thirty students were interviewed across the four classrooms (see Table 3). The student interview protocol was organized into three parts. The first part concerned the content of the observed teaching unit. This segment of the protocol served as a check on student awareness of the overall content of the class. We reasoned that students able to coherently discuss the content of the class would offer a more valid impression of instruction. This would be true even if student understanding of the content was low. Each teacher collaborated with the first author in the design of interview protocols to address the content they taught in the observed unit. Classroom materials used during instruction prompted student thinking about the target science concepts.

The second part of the interview focused on student understanding of the nature of science. Understanding the nature of science was an overarching theme of the ISC project. It was the glue that connected constructivist-based teaching practices to inquiry-oriented science teaching. We reasoned that students able to discuss

elements of the nature of science in a meaningful way would offer a more valid impression of inquiry-oriented instruction. Broad categories relevant to student conceptions of the nature of science were identified from Lederman's (1992) review of the literature on the subject. The categories and interview questions designed to address each category were reviewed for content validity by a high school teacher who is familiar with adolescent students and has studied the literature on the nature of science (see Fig. 2). He noted that asking, who are scientists and what do scientists do, are not part of nature-of-science instruments. While these categories were useful in establishing concrete referents for discussing the nature of science, they were not used to assess student understanding.

The final portion of the interview concerned student perceptions of teaching practice. These questions were designed in a manner similar to the teacher interview protocol. Again the second author who is familiar with the constructivist content of the teacher workshops checked the content validity of the questions (see Fig. 1). Questions related to "Learning about the world" were omitted from student protocols also. This served to maintain a focus on classroom practice and paralleled the teacher interview.

Analysis

Studying discourse in various settings is an appropriate context for applying social semiotic analysis. Social semiotic analysis systematically examines various forms of communication for the purpose of understanding how people make meaning (Lemke, 1990). Social semiotics is concerned with the contexts in which socially meaningful acts take place as well as with relationships among practices, processes, and themes that emerge from an analysis of social activity. This type of analysis has been made of classroom discourse of students and teachers (Cazden, 1988; Pimm, 1987) and in studies of a variety of adult activities (Resnick, 1991).

The goal of social semiotics is to identify major themes or unifying concepts that tie otherwise disparate chunks of discourse together. Where this holistic picture is understood to be coherent by other individuals equally informed on the subject of interest, then the interpretation is considered meaningful (Lemke, 1990). Social semiotics tracks the construction of meaning by associating discourse from different locations or times but where that discourse shares a common base of experience and information as happens with classrooms. The analysis examined the discourse of teachers talking about their teaching, the discourse of the classroom which constituted

a sample of the practice of teaching, and student discourse describing teaching as it related to that individual student or segments of the class.

The analysis involved a systematic examination of the teacher interview to establish what instruction was intended to accomplish with respect to classroom inquiry. These intentions were captured in broad themes that emerged across the interview. Partial transcriptions of classroom video tape and field notes from classroom observations were analyzed for how consistent they were with respect to these instructional themes. In a similar manner, student interviews were analyzed for expression of these same themes. For instance, an instructional theme might be that a goal of instruction was to elicited student thinking. To be established as a theme within the interview, this idea had to be made explicitly in at least two different points in the interview. Data from classroom observations were examined for evidence of teaching practice designed to elicit student thinking. Student interview data were also examined for responses that explicitly describe teaching activity designed to elicit student thinking. At the same time, these data were also examined for evidence that ran counter to the themes.

Results

We will first consider data relevant to the first research question: Are teacher intentions for instruction valid representations of recommended classroom practice presented in ISC workshops? This question was assessed in part by examining the alignment between themes that emerged from teacher interviews and the CLES subscales. To be counted as a theme, the idea had to be raise at least two times during the interview sufficiently removed from each other to be considered independent. Teacher themes are found in the first column of Figures 3 through 6. These figures outline data consistent with themes for each teacher. The second column shows the CLES or STEBI scale that is most closely related to each theme along with the teacher's score on that scale.

A simple count shows that 10 themes were related to CLES categories versus 11 themes that were related only to the STEBI or neither. Given the amount of discretion allowed each teacher to talk about teaching, these results will vary in part by the quantity of teacher talk. However, nearly half the substantive talk, as measured by identified central themes, was focused on themes that aligned with inquiry-oriented instruction. We concluded that teacher intentions were aligned with inquiry-oriented practices with respect to CLES categories.

Teacher interview data were examined for its relationship to inquiry teaching themes. There was considerable variation concerning how teachers implemented their inquiry-oriented instructional intentions. They ranged from Davidson having the impression that specific science knowledge should generally not be told directly to students to Lesh and George having very specific expectations about what students should know. There was considerable agreement across the four teachers that students should be encouraged to share their own ideas about science concepts in class and with each other. There was agreement that science learning occurred when students were working together. However, student interactions were structured differently across teachers. What follows is a brief description of each classroom derived from teacher interviews and expressed, in part, through the voice of the teacher. This characterization will be compared with results from classroom observations and student interviews.

Ms. Jenks, grade 7

Jenks treated student ideas and student talk with a high degree of respect. She believed it was important to generate student ideas about a topic before formal instruction in order to structure further instruction and to foster student thinking. Student expression was encouraged throughout instruction by varying instructional strategies and providing opportunities for student expression. She also recognized limitations in divergent teaching strategies.

> I would say my class, what I think what I wish would happen doesn't always happen....see what kinds of things they know, ...we do a warm-up thing every day where they have a couple of questions that sort of settle them when they come in, they have something to do. Some of those are review from what we've done before, but as I go into a new unit I often use them to just see where they're thinking, and it's definitely a group picture. I use that, and it really only gets those people who will respond.

She employed text-based material and worksheets to explicitly instruct students on a particular topic. She felt that this was a comfortable and secure mode for some students and for those who were not responding, this is one way of getting some response to specific content. Time- and energy-intensive forms of constructivist practice must also be balanced by text-based, explicit forms of teaching as a fall-back position just to survive the job from day to day.

Mr. Davidson, grade 5

Davidson expressed a sincere interest in helping students explore a topic based on their own developing knowledge. However, his view suggested that a constructivist teacher does not give information to students. Rather, the teacher helps students ask questions and guides their activity toward obtaining an answer. This generated concern that there was no way to assess what students were learning other than by listening to their questions and observing their activity. The following excerpt captures the essence of Davidson's perspective.

> Well I see myself not telling the facts, not giving them information only as a springboard to question. I think that was the basic difference in what I was teaching before and how I was teaching. ...What I really liked about the constructive point of view was to let the kids kind of lead in their questioning and then going and creating a curriculum about what their questions were. I like that approach because then they are involved. Then you're taking what they're interested in and what their questions are and trying to create an atmosphere where they can find out on their own. So there's a lot of things I resisted. One thing I resisted was the open-endedness of no closure on a lesson. It bothered me for a long time this year. There's no closure, there's no way of testing this, there's no other way of knowing other than just by what the kids are saying.... So that required me to really redo a lot of testing approach, how do I know.

The omission of closure and withholding information did not represent the intent of the ISC workshops. However, viewing video tape of inservice presentations suggested that this point of view did have basis in workshop experience. This was especially true if one was overly focused on the philosophy of personal knowledge construction behind the demonstrated teaching practices. During the interview, Davidson explicitly stated this point of view and it became one of the central themes used in the analysis of his classroom.

Mr. Lesh, grade 6

Lesh expressed a tension between opening the class to questioning and exploration and guiding students in their work. Lesh is energetic and interacts with a large number of students during each class. There is often a sense of urgency in his questioning as though there is a specific point to be made that is just around the

corner. The following excerpt describes the source of the urgency in terms of efficiency. The reference to the invention of writing concerns a unit on archeology.

> I think that-it's hard to do but I'm working on it, is valuing all points of view, especially the ones you know are misconceptions or inaccurate and acknowledging that that's good and I'm glad you're thinking and trying to credit (the student with) that thinking and at the same time you want to say, but hey writing wasn't invented for another three million years. ...I like to put kids in a problem solving kind of situation and then ask them, how do you want to collect the data, how do you want to display it?... The teacher in me wants to plan and structure and organize because it's more efficient and it's more predictable. I would like to do more of allowing kids to plan their own things.

Lesh was reflective and looked at instruction from various perspectives. He related his broad goals for developing inquiry and expression of student ideas to the variations he perceived in the dynamics of each class. Constructivist practices were mediated by what engaged students quickly and effectively. If giving explicit instructions set a task on a productive course, then he was in favor of doing that. He also understood what could be gained when a task was less structured and what could be lost when explicitness replaced exploration.

Mr. George, grade 7

George's classroom was populated with live animals, such as two foot iguana, large boa constrictor, rabbits, and guinea pigs. These animals did not play a direct role in any of the observed lessons, but students were highly interested in their presence. The animals were an expression of George's belief that children should be physically and emotionally connected to what they study.

> A room without animals to me would just, I can't imagine what it would be like. Because they are kids, that's just an automatic connectedness. ...When they say wow, this is not a classroom, this is a zoo ya know, well that makes me feel good. That means this is a place where they would like to come. ...On the other hand you have the negatives if the iguana says he's gonna go to the bathroom when you really feel like you're ...really working...that stops. You have to wait so the animals can take the class away from you anytime they want, it's there.

George feels a tension between opening the class to questioning and exploration and guiding students in their work. Students have opportunities to express their ideas but the science content forms the structure of the class.

> I'm doing this constructivist thing where I'm starting to see where they start from and I try to build on that. Once we get going on that I guess the main things that I try to do that I feel are important, first of all I feel reading and the content area in science is far different than the reading they do in other areas. I try to teach them the tricks early on of how to do that, of how to read slowly. Then I do a lot of concept and nature mapping. ...I do a lot of that and as far as introducing material, sometimes we read it, sometimes we brainstorm it.

When asked if he involved students in helping plan the content of lessons his reply was: "...I'll given them choices sometimes and the problem with that is it's hard to direct their learning when they don't know the choices." He feels strongly that students should be expressing what they know and what they want to know. He has developed some specific practices for eliciting their ideas. These were in place before the ISC project but have been treated somewhat differently in his attempt to focus on student ideas. Through concept mapping, students should understand that there are numerous ways information can be organized and should appreciate points of view offered by other students.

Teacher Intentions and Teaching Practice

After establishing that teachers intended to conduct major portions of instruction in an inquiry-oriented manner, the next question was to determine if direct observations confirmed that these intentions were translated into observable teaching practices. We expected this question to be made problematic by wide variations in teaching practices. For instance, Mr. George and Mr. Davidson tended to directly address the theme of student expression of ideas and construction of understanding. Ms. Jenks was more indirect. The following is a description reconstructed from field notes in Mr. George's class.

> The purpose of the class was to work on a concept of wetland.
> The teacher discussed differences between a student 'concept' of wetland and a dictionary definition.

"Yours is more lengthy and will change to accept new information. You will construct a concept like building a house. You know in general about a house but not what a construction worker knows. Some of your ideas are misconceptions."

What followed was a discussion of a general understanding of wetlands structured around a brainstorming activity that lasted over 10 minutes. Student ideas and questions were generated. Anecdotal evidence was marshaled from student knowledge and experience to address questions. Teacher behavior and the structure of instruction supported the conclusion that the teacher wanted students to use personal background knowledge to begin building an understanding of wetlands.

Ms. Jenks followed a more indirect approach. She first initiated a specific activity: to examine the structure and function of bird wings and feathers. Within the context of this activity, her questioning and general open demeanor promoted inquiry-oriented expression of ideas and application of knowledge. This description was reconstructed from field notes.

Teacher: What job does your bird have? (behaviors in wild, functions needed to survive) Look at wing shapes. The form follows function. Notice the soaring birds wing.
Student: Are humming birds high speed birds?
Teacher: Good idea. (General discussion of wing types and of what different birds do in wild. Students have little specific idea of how most birds behave.)
Teacher: Wing types are probably mixed in real birds.
Student: Should we write what wing shape mine has?
Students continue drawing and relating ideas about flying to sketches.
Teacher: Have you ever noticed bird feathers? In feathers, form follows function as well.
Teacher prompts thinking about question and three students get involved.
Student: Would breaking a feather hurt a bird?
Student: I think where it is stuck in it would hurt.
Student: Like a finger nail.

While interview protocols showed that teachers sought to elicit student ideas, there was less evidence concerning the role these ideas had in investigations or activities. Student ideas played the most direct role in Mr. Davidson's class. Students

were repeatedly asked to make observations, raise questions, and write them down. Students maintained running notes from day to day in their study of snails. Davidson periodically recapitulated their observations and questions. These open discussions were wide ranging and often revealing about student thinking. During one observation, 11 different students in a class of 28 expressed ideas stemming from their direct classroom observations of snails. Davidson, however, did not lead the discussion toward a summation or closure on particular understandings about snails.

For an observer who is looking for evidence of inquiry-oriented teaching practices it was there to be found. All four teachers are experienced at their grade levels and have accomplished rapport with their students and earned their confidence. However the next important question is whether students perceived instruction as promoting inquiry as characterized by teacher intentions. A potentially confusing factor for students was that there were considerable variations in the way these teachers prompted and promoted an atmosphere of inquiry, and that they also taught using a variety of other methods. Mr. Lesh, for example, was very specific in guiding his students through activities designed to teach aspects of the nature of science. One session of small group work asked students to identify features of a set of rocks that could be used to classify them into ad hoc groups. They were then to use their ad hoc scheme on the rocks from other groups. The structure of this activity explicitly guided students through the creation and application of a classification scheme. If asked, would students characterize the work in this classroom as stimulating the expression and use of student ideas? Would students recognize this type of expressive activity as part of the teacher's intended instruction to improve science learning? Would students agree that pursuing student thinking and sharing ideas among students would support learning science? These are the questions to which we now turn.

Alignment of Student Perceptions with Teacher Intentions and Teaching Practice

Are student interpretations of teaching practice aligned with teacher intentions and with observed teaching behavior? It is convenient to treat these two questions together. There was evidence from classroom observations for each inquiry-oriented theme derived from teacher interviews. The observational window was too small to claim that these themes characterized instruction in these classrooms. The student data provided additional validation for teaching practice through student descriptions of classroom experiences and impressions where it was consistent with teacher intentions or less validation where students were silent about elements of teaching

practice. In a few cases, student interview data was inconsistent with the teacher intentions. Student comments also represented perceptions developed over the school year and therefore offer a broader observational window into these classrooms.

Students were interviewed concerning their understanding of the topic of instruction and their understanding of the nature of science. These data are more extensive than can be reported here and are analyzed elsewhere (Flick, Lederman, & Enochs, 1996). For the purpose of this study, all of the students were considered to have a coherent understanding of the nature of the instructional activities. While they ranged in their understanding of the content, they were all judged sufficiently engaged with the class to offer valid information. Their responses to questions about the nature of science suggested that they understood inquiry to involve the gathering and communication of data as well as the importance of being skeptical and verifying evidence. Therefore, students were judged to understand the nature of instruction designed to stimulate inquiry.

Figures 3 through 6 show examples of data related to each theme derived from an interview with each teacher. The first column contains a description of each theme derived from teacher interviews along with a statement of how many of the student interviews contained references to the theme. For instance, in Figure 3, theme A for Ms. Jenks is "Assessing what kids are thinking." This theme was mentioned by 5 of the 6 students interviewed in her classroom. The next column contains the CLES or STEBI subscale score is relevant for that theme. The center column contains examples from the teacher interview used to establish the theme. The fourth column contains examples from classroom observations that were used to establish that the teaching practices were observable. The final column contains examples from student interviews that address each theme. If the student data contained statements that were inconsistent with a theme, then a negative example is included. Students are identified by a four character code. The characters in order are: (a) teacher initial (pseudonym), (b) order in the interview process, (c) F for female and M for male, and (d) student identified by teacher as high , H, medium, M, or low, L achiever.

Data from Jenks classroom indicated that her students perceived her intentions and teaching practices related to her inquiry-oriented instructional themes. The themes aligned with sections of the CLES (see Fig. 3) were Theme A: "Assess what kids are thinking" and Theme B: "Letting students contribute to the curriculum." Themes are listed in order of those aligned with CLES first, followed by those aligned with STEBI, followed by others. There was a high level of consistency among the six

students interviewed. There was only one student statement by J4MH (see Fig. 3) that was inconsistent with Jenks theme of assessing what kids think.

Students described the use of an initial warm-up activity as a tool for soliciting their thinking. Students spoke of getting "people's opinions" for the purpose of hearing what other people think. J3FM described discussions as "usually we make our reflections...sometimes word how we feel about (a topic)." This was in keeping with an affective tone in Jenks interview as indicated in this example: "That would be my goal," she said of engaging student thinking, "they could choose within broad areas...if they're motivated they want to learn and it has to be personal."

The one student (J4MH) who expressed the view that students do not discuss what they are thinking about science topics seemed to suggest that it took too much time to discuss ideas and that students did not say much. This student was identified by Jenks as a high functioning student but he seemed to think that the class was hard.

> J4MH: Some people do (say what they think) like, ya know, like this is too hard, and stuff like that. I just do it and get help from my parents sometimes if it's too hard. Usually I get good grades in science.

Students said that they were able to contribute to the curriculum by discussing and comparing ideas with others. "Well sometimes a neighbor understands more about something or knows more about it. And you know they have different opinions and ideas about it too. That works." This view was mediated by an understanding that input also came specifically from materials presented by the teacher. Comparing ideas with other students was important but Jenks theme of "Teaching students background information" was clearly represented in student comments. Thus, her students apparently distinguished between teaching practices intended to directly teach science concepts and teaching practices intended to promote student inquiry.

Themes D and E concerned teacher efficacy and credit for student outcomes. It is unlikely that students at middle school level would reflect on these aspects of teaching. Given the conditions of the interview, students were not likely to be overtly critical of the teacher. Similar themes appeared with other teachers and were not commented on by students.

Data from Davidson's classroom suggests that students understood quite clearly that they were to make observations and raise questions in line with his instructional intentions. All 10 students made statements consistent with theme A (see Fig. 4). Students had mixed comments concerning why Davidson offered or withheld

information. The following are examples of student comments on this central feature of Davidson's teaching:

> D10FL: He pretty much never tells us and tries to make us figure it out.
> D5MM: Mr. Davidson doesn't really tell us a lot about it, he makes us think about it. ...he said we have to figure it out by ourselves and we did.
> D3ML: He kind of just tells us a little bit about it and then he tells us what to try to figure out and stuff.
> D2FM: First of all he doesn't give us the answers, he always has us look them up. That kind of helps us cuz when you're looking something up you also find something else you dint' know about.

There were at least two other students were not completely aware of the intended effects of Davidson's inquiry-oriented instruction. The following are examples from student interviews:

> D7MM: Usually either he's not telling us he wants us to figure it out on our own or he tell us then later we figure out it's wrong. There's been a lot of times I've wanted to know things, like I want to know if that's his breathing hole or it that bump on his shell is his heart. I want to know a lot of different things, and I still don't know yet.
> D8MH: He'll explain things, like if you ask him a question... he'll give us sheets explaining things.

These statements were made as a matter-of-fact as though the students had accepted that this as the way science was to be taught. However, they did not sound satisfied. In other cases there was an air of pride, "If he just tells us the answers, then what would be the point of doing this."

Students were deeply interested in the study of snails and had been actively involved in making many direct observations. This atmosphere appeared to lead students toward an attitude of looking "stuff up and not depending upon somebody else for answers." They felt they got more ideas from sharing information with each other (theme B, Fig. 4) and could actively debate with peers about which ideas seemed correct (theme D, Fig. 4). This informal, almost ad hoc mode of learning science, aligned with Davidson's expressed view that there should be no closure in an inquiry-oriented class.

Students were far less vocal about theme C, the "content of the curriculum is student observations in response to student questions. Three students commented on this theme, D2FM, D3ML, and D9ML. It may be noteworthy that two of these students were identified as low achievers by Davidson and the other as medium. He was quite specific in his interview that his new approach to teaching was beneficial to his lower achieving students.

> ...You know what I observed after this lesson? The lowest students in the class were on the same level with the high IQ kids when we were doing that lesson. They were coming up with observations that were right on the same par level with the more intelligent kids. That's what surprised me I think more than anything else.

D9FL's comments are particularly telling relative to Davidson's observation.

> ...Because if we keep on looking we might be able to find out on ourselves and not through paper and information. ...Pretty much if you figure it out yourself, you'll learn a lot more about it instead of just looking in a book. ...You might find out things that aren't in the book.

If student observations and questions comprises the content and text knowledge is used for comparison only, then the reluctant readers and reluctant students are in an environment where they are more likely to be able to make direct contributions. Whether or not this strategy is an overall improvement to learning for this class is difficult to say. The mix of student data across themes A, B, and D suggest that the other students are not feeling left out.

Data from Lesh's classroom (see Fig. 5) reflected the tension that Lesh expressed between direct or explicit teaching and inquiry-oriented methods. The students themselves did not directly express this conflict but their description of teaching straddled both sides of this issue. Initially, the Lesh interview was analyzed into themes for both forms of teaching. Subsequent readings in light of student data suggested that Lesh was struggling for a balance between both forms of teaching (theme B, Fig. 5). For example, a student supported Lesh's theme A of "Promotes student expression in the form of thinking and reasoning" by noting Lesh asks for other people's opinions and expects students to discuss ideas out loud. Students expressed this view in the following ways:

R2MH: (He asks) Just what you thought about the question.
R6FM: I mean all the kids in my class listen to everybody else to see what the explanation is. Just to see what everybody thinks about everything.
R5MM: I think a lot of times it's talking to other people with a little help from the teacher because then you learn it on your own.

On the other side, students perceived that Lesh wanted them to learn specific ideas in science. They reflected his intention that he was directing the activities and they were there to listen and learn.

R3FL: If there's something we don't understand, he'll explain it more than what he did before.
R4MH: Ya, then he says something like if their (ideas) are wrong he says something that it kinda has something to do with the idea, but its the right idea that they could have been thinking about but not what they were (saying).
R1FM: ...but it's hardly ever that anybody (expresses any ideas) because they're here to learn...

Lesh's struggle with the appropriate balance between explicit and inquiry-oriented teaching is also expressed in his CLES "Learning to Learn" subscale score of 19/30 (see Fig. 5). This scale includes statements about students helping to plan instruction, select activities, and assess progress. Lesh's agreement with these statements is low relative to his scores on the "Learning to Communicate" subscale (30/30) and "Learning to Speak Out" subscale (23/30). Lesh's instruction has communicated to students that their ideas are welcome but that he has a specific agenda. Note that all six students interviewed commented positively relative to themes A and B (see Fig. 5).

Data from Mr. George's classroom (see Fig. 6) were similar to Lesh's students. George wants his students to "Learn to Speak Out" (CLES subscale score 30/30) but to focus that expression around very specific content. His "Learning to Learn" CLES subscale score was lower (16/30) perhaps reflecting an unspoken uncertainty about the balance between inquiry and direct teaching. Students comments on George's use of warm-up questions at the beginning of class supported the theme of "Assessing what kids are thinking." A prototypical comment was "He always says no matter what, write it down... it will help you get your own idea." Students spent a considerable

portion of one class, brainstorming knowledge they had about wetlands. Students were motivate during that class and interview data supported that sense of motivation. One girl spoke of explaining a science experiment she had done as a "cool" experience. However, even though "Motivating students" was a theme (D, Fig. 6) in the George protocol and observations confirmed his verbal encouragement, students were split or silent concerning this aspect of his teaching. Only two student protocols (G1ML and G4ML) contained statements consistent with theme D. Three others (G5MH, G6FH, and G7FM) were either negative or mixed. As with Davidson's students, these students split between the low and high achievers as identified by George.

Student protocols suggested that they perceived that George had a very specific agenda. "We study and study and he knows exactly what he wants us to learn..." Warm-ups were perceived as forums for expressing ideas but also for processing information. For instance, G2MH offered this description, "Every couple of days... I'll actually have a discussion. We'll be doing warm-ups and it's like what do you think this word means, is it that one or was it that one. We'll have a discussion about that. Then I missed one and I was like don't talk during warm-ups." The students may be perceiving the pedagogical tension between helping students express ideas and presenting specific information. While only two of seven student protocols addressed theme D, six addressed theme E, "Helping students learn background information" (see Fig. 6).

George used "mindmaps" for helping students communicate what they had learned (theme B, Fig. 6). However, students did not always share George's view that his "mindmaps" were a way of building and sharing ideas. In fact, the strategy of mindmaps was mentioned specifically by only two students. It may be that mindmaps were lumped into what students called "just paperwork." Where one student saw mindmaps as a way of seeing "what you've learned and branch it out" others saw it as just another note taking activity related to explicit instruction.

George himself expressed an ambivalence over the CLES "Learning to Communicate" subscale (14/30). Statements in this section of the CLES concerned students talking to each other to explain ideas or solve problems. While George valued what his students thought, the process of soliciting ideas was closely controlled. At least part of the purpose for controlling student talk may have stemmed from students talking too much. At least one student commented on Mr. George "getting mad" and having to shut down the discussion. Such comments were rare across the four classrooms. The rarity of comments critical to classmates and the

teacher should be considered carefully. Students were interviewed in proximity to their own classroom by a person that they barely knew. Being highly candid carried some risk that information would leak out even though they had been assured of confidentiality. There may have also been a sense of presenting a positive side to "their class" and "their teacher." Whatever the student view of the interview context, they did not perceive the avenues for self-expression in the class in the same way as George.

Discussion and Implications

These case study interpretations followed the communication path from teacher thinking and intentions for instruction, through a limited observational validation of instructional implementation, to how students interpreted instruction. To the extent that interview protocols were valid with respect to inquiry-oriented instruction, students and teachers in this sample of four classrooms communicated both implicitly and explicitly about the intent of inquiry teaching practices. This was true regardless of how well the teacher actually implemented the recommended practice. The students interviewed generally expressed confidence and trust in their teacher. Twenty-seven of the 30 students said that their ideas and questions were wanted and usually heard. They said that they had some input into the content of instruction and that the teacher did things that supported learning and in many cases supported inquiring into subject matter.

This positive state of affairs can be understood by contrasting what was heard from teachers and students with what we did not hear. Teachers did not "bad mouth" the students and likewise the students did not "trash" the teacher's skills or intentions. Some students hinted at a lack of motivation and would like for portions of the class to operate differently. However, students were not opting out of instruction nor were they trying to hide from participation. The atmosphere of these classrooms showed a mutual trust that may mask a clearer picture of the state of inquiry teaching and learning.

Data from the classrooms of both Davidson and George suggested that their methods may have been perceived more favorably by lower achievers than by higher achievers. If lower achievers are gaining greater access to the learning environment then the particular implementation of inquiry-oriented practices in those classrooms may offer a basis for further study. However, there were questions raised by the protocols of higher achieving students about their own motivation and involvement. How information was shared by the teacher in these two classrooms contrasted

sharply with one another. Despite a general consistency between teacher intentions and student perceptions, there may be other levels where students and teacher misunderstand one another. The Carter & Jones (1994) heterogeneous, high-low achievement dyads talked more, took more turns, and stayed on task better than low-low dyads. The explicit structuring of the dyads very likely communicated the intention of the instructional practice to the students in these classrooms. It may be that explicitly communicating instructional intentions and supporting more interaction among higher and lower achievers would improve the learning environments in classrooms of Davidson and George.

Students perceived the intention of teachers to explicitly present information even as the teacher deliberately applied inquiry-oriented instruction. Both Lesh and George wrestled with the tension between explicit and inquiry-oriented instruction. Jenks and George each had a theme of instruction focused on helping students learn specific background information. Current models of inquiry instruction are relatively silent about the relationship between explicit and inquiry-oriented teaching. The teachers in this study work out that relationship on a weekly basis in their classrooms. But tensions and uncertainties persist. Students and teachers are not always clear how student ideas can interact constructively with instruction. This study has provided some descriptive detail of how the different players perceive the classroom operating. This detail can be used to support efforts to generate new instructional designs that integrate development of explicit knowledge and inquiry instruction.

Lesh, George, and Jenks each had ways to engage students from the very beginning of class. The term "warm-up" was used variously to refer to reviewing material or stimulating thought about a new topic. But in each case the teacher did not allow the class to start inadvertently. While students may have been asked to share ideas, there was little doubt as to who was leading the class. Even Davidson, who had a more informal approach to instruction, clearly controlled the vast majority of events. It may also be said that these four teachers also controlled the cognitive atmosphere. As G7FM said, "We study and study and he knows exactly what he wants us to learn..." But the intention is more than knowledge, there is a classroom agenda for expression and inquiry. The agendas were not the same across teachers and may even be contradictory, but each exerted a major influence on the learning atmosphere of each classroom. This may represent developmentally appropriate accommodation between early adolescent students and their science teacher. These students are beginning to hold abstract ideas and take evidence into account but are just as likely to change either in midstream (Keating, 1990). Naive theories and perceptually

dominated thinking will persist for these students for years to come. A strong instructional leader who is also a thoughtful and caring cognitive mentor may offer the necessary structures that support student expression of ideas and help maintain a sense of inquiry. G7FM captured the idea again, "...when you just try to figure it out with your whole group, the whole science level circles around you. It's really neat."

References

Anderson, C. W. & Roth, K. J. (1989). Teaching for meaningful and self-regulated learning of science. In Brophy, J. (Ed.) (1989). Advances in research on teaching Vol. 1. Greenwhich, CN: JAI Press, Inc.

Carnegie Foundation (1995). Turning points revisited. New York: The Author.

Carter, G. & Jones, M. G. (1994). Relationship between ability-paired interactions and the development of fifth graders' concepts of balance. Journal for Research in Science Teaching, 31, 847-856.

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

Crawford, B. A. (1996). Examining the essential elements of a community of learners in a middle grade science classroom (Doctoral dissertation, University of Michigan, 1996). Dissertation Abstracts International, 57, 9624591.

Enochs, L. G. & Riggs, I. M. (1990). Further development of an Elementary Science Teaching Efficacy Belief Instrument: A preservice elementary scale. School Science and Mathematics, 90, 695-706.

Flick, L. B. (1996). Understanding a generative learning model of instruction: A case study of elementary teacher planning, Journal of Science Teacher Education, 7, 95-122.

Flick, L. B., Lederman, N. G., & Enochs, L. G. (1996). Relationship Between Student Perspectives on Inquiry-Oriented Teaching Practice and the Nature of Science. National Association for Research in Science Teaching: Final program and abstracts, St. Louis, MO, March 31-April 3.

James, R. K. & Smith S. (1985). Alienation of students from science in grades 4-12. Science Education, 69, 39-45.

Jones, M. G. & Carter, G. (1994). Verbal and nonverbal behavior of ability-grouped dyads. JRST, 31, 603-619.

Keating, Daniel P. (1990). Adolescent thinking. In S. S. Feldman & G. R. Elliott (Eds.). At the threshold: The developing adolescent. Cambridge, MA: Harvard University Press.

Kelly, A. (Ed.). (1987). Science for girls?. Philadelphia, PA: Open University Press.

Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. Journal of Research in Science Teaching, 29, 331-360.

Lemke, J. L. (1990). Talking science: language, learning, and values. Norwood, NJ: Ablex Publishers Corp.

National Research Council (1996). National science education standards. Washington, D.C.: National Academy Press.

Pimm, D. (1987). Speaking mathematically: Communication in mathematics classrooms. New York: Routledge & Kegan Paul, Ltd.

Resnick, L. B. (1991). Shared cognition: Thinking as a social practice. In L. B. Resnick, J. M. Levine, & S. D. Teasly (Eds.), Perspectives on socially shared cognition. (pp. 1-20). Washington, DC: American Psychological Association.

Roth, W-M. (1994). Experimenting in a constructivist high school physics laboratory. Journal of Research in Science Teaching, 31, 197-223.

Sanford, J. P. (1987). Management of science classroom tasks and effects on students' learning opportunities. Journal of Research in Science Teaching, 24, 249-265.

Taylor, P., Fraser, B., & White, L. (1994). CLES: An instrument for monitoring the development of constructivist learning environments. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Tobin, K. G., Kahle, J. B., & Fraser, B. J. (1990). Learning science with understanding: In search of the Holy Grail. In K. H. Tobin, J. B. Kahle, & B. J. Fraser (Eds.), Windows into science classrooms: Problems associated with higher level cognitive learning. London: Falmer Press.

Table 1
Teachers in sample ranked by total CLES scores

Teacher	Gender	Years Experience	Grade	Instructional Topic	CLES Total Score (150)
Jenks	female	3	7	Form & Function in birds	130
Davidson	male	35	5	Snails	128
Lesh	male	10	6	Nature of Science	121
George	male	6	7	Form & Function in birds	98

Table 2
CLES and STEBI Scores for Teachers in Study and for Other Teachers in Cohort

		STEBI	
	CLES (150)	Outcome Expectancy (60)	Self-Efficacy (65)
Ms. Jenks	130	43	40
Mr. Davidson	128	48	47
Mr. Lesh	122	37	53
Mr. George	98	59	57
Sample Average	119.5	46.8	49.3
Average of eight 5-7 grade teachers in ISC	118.7	43.6	44.1

Table 3
Number of Interviews by Classroom and Gender

Teacher (grade)	Boys	Girls	Total
Jenks (7)	3	3	6
Davidson (5)	7	3	10
Lesh (6)	3	4	7
George (7)	4	3	7
Total	17	13	30

Central Theme of Teacher Intention	CLES or STEBI Response Category	Teacher Interviews	Classroom Observe	Student Interviews
A. Assessing what kids are thinking. Mentioned by 5 of 6 students interviewed	CLES Learning to Speak Out subscale score 26/30	"(19)...there is an assessment of where the kids are (with the warm-up)...when we begin a new topic. (348)...I want to know what they are really thinking. (353)...To put (ideas) into a larger framework."	Intersperses teacher input with hands-on observation with open-ended questions.	J3FM: Probably the warm-up. She gives us questions. ...She gets a bunch of different people's opinions... We can hear of what other people have to think of what it is. Negative Example J4MH: (Students express what they think?) Not really, cuz then it takes up class time and people are like shut up.
B. Letting students contribute to the curriculum. Mentioned by 6 of 6 students interviewed	CLES Learning to Learn subscale score 24/30 CLES Learning to Communicate subscale score 30/30	Begins year with list of what students want to learn and revisits it throughout the year. "I wish they'd influence (the curriculum) more. ..."(This process seems) sort of hollow because I feel like there's certain things we've agreed to cover..."	No data on this theme contained in observations.	J2MM: ...cuz they may know something that you didn't know. J3FM: ...to see what other people's ideas are and if they think they're right and what you think. J6ML: ...you are able to talk to another person and se what he thinks and what you think and decide on one.

C. Uncertainty about performance of teaching practices.	STEBI Efficacy 40/65	"(16)...what I wish would happen doesn't always happen. "(294) (support kids in directing activities is) a little hollow. ...doesn't go as deep as it could if ...I was maybe a better manager of groups..."		No student expressed negative criticism of her teaching. While the interview focused on classroom practice, proximity to the classroom and other constraining factors would make it uncomfortable for a student to be openly critical of a teacher.
D. Ambivalence about taking credit for student learning.	STEBI Outcomes 43/60		Difficult to make direct observations of this theme. She regularly affirmed student efforts and encouraged and suggested further effort.	
E. Teaching students background information. Mentioned by 6 of 6 students interviewed		"(76)...For some kids (reading the text and answering questions is) an interesting way to get the background information and its also a way I know they're getting at least in... (92) I definitely do use worksheet types of things, but I tend to not make them independent as much as discuss these things."	Directs students to make specific observations. Poses questions that prompt those observations. Pushes students to state relationships and follows with specific information. "What about design of feather? Why is this good? What about design that makes this happen? How does this work? Overlap and hooks & works like a zipper."	J3FM: (A typical class would be) probably reading out of the textbook, having one of the animals...studying it... J2MM: ...if there's a word she'll pronounce it for you or tell you what it means... J5FH: Usually objects, usually it would just be books,...

Figure 3: Data aligned with each instructional theme of Ms. Jenks.

Central Theme of Teacher Intention	CLES or STEBI Response Category	Teacher Interviews	Classroom Observe	Student Interviews
A. Students are encouraged to observe and question. Mentioned by 10 of 10 students interviewed	CLES Learning to Speak Out subscale score 27/30	(79) ...let the kids kind of lead in their questioning and then going and creating a curriculum about what their questions were. (160) So they started theorizing and putting down their own questions... So from that you have to provide them some... visual stimuli to get them interested. ...In terms of maybe even finding out what they want to do or what they're looking for.	A typical classroom procedure was the following: "Without looking at your snail, write for one minute what you know about your snail." After about a minute, "Write a few questions you have about your snail." Finally, "Who'd like to share a question?"	D7MM: All of a sudden in the middle everyone's hands go up asking questions or trying to answer them or coming up with new thing to tell. I think science is fun. ...I get "wows," he says "Very good questions." I don't know if he's just trying to make me feel good. D2FM: If he just tells us the answers, then what would be the point of doing this. That's what he wants us to have is questions... look stuff up and not depend on somebody else for answers.

B. Teacher provides information only as a way of generating more questions and does not bring closure. Mentioned by 6 of 10 students interviewed	CLES Learning to Learn subscale score 23/30	(63) Well I see myself not telling the facts, not giving them information only as a springboard to question. (411) ...review... go back to their questions before and take off from there. Sometimes they never had any closure at all, most of the time we didn't.	A student states that he has seen "baby snails" crawl up inside the whole on the side (anal opening). The teacher presses for whether is a "fact or observation or a guess." Other students confirm this behavior. The teacher later comments, "You said things that really got me thinking... like babies going inside to get moisture." No additional information was provided.	D9ML: Well he asks us questions and observes stuff and he waits until you try to figure them out. He pretty much never tells us and tries to make us figure it out. Then if we don't figure it out he'll tell us. D7MM: One thing, he doesn't tell us the answers. We ask him things and he doesn't tell us the answers. He want us to know on our own... <u>Negative Example</u> D8MH: He'll explain things, like if you ask him a question... he'll give us sheets explaining things.
C. Content of the curriculum is student observations in response to student questions. Mentioned by 3 of 10 students interviewed	CLES Learning about Science subscale score 25/30	(138) ...taking that snail out..., putting him on plastic, and doing the same thing, observing every part. ...I was very surprised they could observe like they did. (311) I started seeing how important it was they wrote their questions down and their observations down.	A previous lesson involved observing snails using a magnifying glass and plastic acetate sheet for observing from underneath. Today students are asked to "write everything you know about eyes. About the mouth. About the foot." These records of observations primed an eight-minute discussion about what students knew about their snail.	D3ML: We're trying to find new things out of the snails and see what happens. Some people felt they had the babies inside the shell and some people thought they laid eggs. ...(to check this idea) I picked it up and looked in that little hole (anus) and a baby just fell out... D9FL: ...Because if we keep on looking we might be able to find out on ourselves and not through paper and information.

D. Questioning and observation are stimulated by small group discussions. Mentioned by 7 of 10 students interviewed	CLES Learning to Communicate subscale score 28/30	(344) ...I try to get from them sharing with each other, how they shared with each other and how they changed their mind after sharing with a friend or the information a friend gave them... (371) ...they're asking each other questions and trying to understand what the other person is trying to say, so that's good.	Small groups are informally constituted with students talking to others by how desks are grouped. The teacher encourages students to discuss their observations and to see if your friends can see what you see.	D4FM: Ya, we are in groups, we talk about the snails, tell each other what we have found out, we write down new ideas, kind of switch it around, and we get more ideas... D10FL: Ya, kind of, cuz you get everybody else's idea and your idea and you guess what one and see what one is right.

Figure 4. Data aligned with each instructional theme of Mr. Davidson.

Central Theme of Teacher Intention	CLES or STEBI Response Category	Teacher Interviews	Classroom Observe	Student Interviews
A. Promotes student expression in the form of thinking and reasoning Mentioned by 6 of 6 students interviewed	CLES Learning to Speak Out subscale score 23/30 CLES Learning to Communicate subscale score 30/30	(256) ...if the student doesn't know why they're doing something, then they shouldn't be doing that because it's not gonna have any value and it's not going to... have any meaning for them. (479) I think my job... is to take them into thinking, reasoning, and communicating their ideas clearly.	Lesh conducts a high energy class generating high numbers of questions and student comments. Many students talk and many are called on to increase participation. Questioning can become fast paced even when eliciting student ideas. Lesh also incorporates individual and group writing to change the pace of class and change the mode of expression.	R2MH: Well he just accepts (student ideas) like he sometimes even asks for other people's opinions on what they were doing... R4MH: ...like doing some science experiments... it can be anything like rocks or bushes... Explain stuff like using smaller words or recreating their explanation...

B. Balancing problem-based instruction with efficiency of instruction. Mentioned by 6 of 6 students interviewed	CLES Learning to Learn subscale 19/30	(28)...I try to minimize the amount of direct instruction, the teacher lead kind of instruction model and try to maximize student centered activities... (51)...but then in order to make sure it gets covered ya end up falling back on the old..., if they don't get them in the first ten or fifteen minutes... Then they just practice and ya fall back on that. (299) ...I like to put kids in a problem solving kind of situation and then ask them, ...to collect the data, ...to display it, ...The teacher in me wants to plan and structure and organize because it's more efficient and it's more predictable.	Students are always operating within well described limits both in terms of personal behavior and activities in science. When students are organized into groups, the teacher observes and gives feedback on individual and group behavior. His questioning always has a content focus in the background even when he is soliciting divergent thinking.	R1FM: We choose a science topic, maybe rocks, maybe animals and we look at things and we try to decipher how old they are or how they were made... he gives us films and we take notes... but it's hardly ever that anybody (expresses any ideas) because they're here to learn... R3FL: We read out of (the text) sometimes, but most of the time... We just talked and did activities. Like how much would you weigh on different planets and stuff.
C. Takes some credit for improving learning with low achievers. Mentioned by 2 of 6 students interviewed	STEBI Outcome 42/60	(131) Sometimes ya I'll take some credit for it because sometimes you ignite the spark. (166) Sometimes I can take the credit... Especially a lower achieving kid...	Indirect observational evidence includes seeing students bring in articles, objects, and pictures from home concerning the topic of study.	R6FM: Even though some kids make fun of and say, "You're wrong, you're wrong," I still say my explanation and he just encourages us...

Figure 5. Data aligned with each instructional theme of Mr. Lesh.

Central Theme of Teacher Intention	CLES or STEBI Response Category	Teacher Interviews	Classroom Observe	Student Interviews
A. Assessing what kids are thinking. Mentioned by 5 of 7 students interviewed	CLES Learning to Speak Out subscale score 30/30	(21)...I'm starting to see where they start from and try to build on that. (554)...there is a trust and a feeling you can make them express themselves.	Warm-ups require students to write ideas in notes. This is followed by whole class discussion. Brainstorming involves the whole class and sometimes class note takers at the chalkboard.	G5MH: He always says no matter what write it down... it will help you get your own idea. G7FM: ...I told them about a science experiment I had done... It was pretty cool. G4ML: Ya, sometimes we talk about (our ideas)... Warm-ups... whatever you think... put it down... you'll learn from that. <u>Negative Example</u> G1ML: No. ...Sometimes whenever we do warm-ups. ...He asked me why I said that, and I said I just wrote it down cuz that's what I think it is.
B. Students communicate what they have learned such as through mindmaps. Mentioned by 4 of 7 students interviewed	CLES Learning to Learn subscale score 16/30 CLES Learning to Communicate subscale score 14/30	(82)...I try to have them have oral presentations from mind maps and different things. (414)...I used the program Inspiration, concept mapping, ...to show them that there are a number of ways to organize their thoughts.	Mind maps were a part of two of the four lessons observe. Distributes legal size sheet for taking notes and eventually making map. What they know goes on left and what they want to know goes on right. The general approach is to make before and after a unit of instruction.	G3FH: ...mind maps, we do lots of mind maps... you get to kind of see what you've learned and branch it out. G2MH: Ya we'll have discussions about what parts of the cell can represent different parts of in our life.

C. Uncertainty about performance of teaching practices.	STEBI Efficacy 57/60	(92) I've been very aware of (gender issues), I'm not sure I'm doing the right things. (282) I think I probably handle (student criticism of content) well most of the time...I don't know whether I give (enough) time.		
D. Motivating students. Mentioned by 2 of 7 students interviewed		(73) I try to make the classroom where kids can have success. (161) They won't raise their hands, but when I ask them to try...it's non-threatening.	Maintains a positive demeanor throughout the class. Moves around classroom during group work and talks individually with students. Quietly encourages students.	G7FM: ...when you just try to figure it out with your whole group, the whole science level circles around you. It's really neat. Negative Example G6FH: He explains and draws pictures and gives out articles and takes quizzes and all that stuff. ...Not so helpful. ...We should like observe things ...like go on a lot of field trips...

E. Helping students learn background information. Mentioned by 6 of 7 students interviewed		(359)...Getting that original background information so that they have a generalist's idea...before they can...decide what to study. (415) I try to show them that their number of ways to organize their thoughts and then I actually try to teach it so that there's a learning experience where you gather all information and then there's a time when you kind of organize it and then you present it.	He intersperses presentation of content and elaboration of ideas between and within activities.	G4ML: The teacher telling you about something and having you read... worksheets. G7FM: We study and study and he knows exactly what he wants us to learn... G1ML: Sometimes Mr. George talks to us and tells us to write down notes... just paper work.

Figure 6. Data aligned with each instructional theme of Mr. George.

SE 060 810

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Teacher Intentions, Teaching Practices, and Student Perceptions of Inquiry-Oriented Teaching	
Author(s): Lawrence B. Flick & Valarie L. Dickinson	
Corporate Source: Oregon State University	Publication Date: March 22, 1997

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following options and sign the release below.

	Sample sticker to be affixed to document	Sample sticker to be affixed to document	
Check here Permitting microfiche (4"x 6" film), paper copy, electronic, and optical media reproduction	"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."	"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."	**or here** Permitting reproduction in other than paper copy.
	Level 1	Level 2	

Sign Here, Please

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature: Lawrence Flick	Position: Assistant Professor
Printed Name: Lawrence B. Flick	Organization: Oregon State University
Address: Oregon State University, Science & Mathematics Education, Weniger Hall 263, Corvallis, OR 97331-6508	Telephone Number: 541 (~~541~~) 737-3664
	Date: May ~~17, 1995~~ 1, 1997

OVER

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC , *or*, if you wish ERIC to cite the availability of this document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents which cannot be made available through EDRS).

Publisher/Distributor:	
Address:	
Price Per Copy:	Quantity Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name and address of current copyright/reproduction rights holder:

Name:

Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC Clearinghouse for Science, Mathematics and Environment Education
1929 Kenny Road
Columbus, Ohio 43210

If you are making an unsolicited contribution to ERIC, you may return this form (and the document being contributed) to:

ERIC Facility
1301 Piccard Drive, Suite 300
Rockville, Maryland 20850-4305
Telephone: (301) 258-5500