# Identification – Interpretation/Evaluation – Response: A framework for analyzing classroom-based teacher discourse in science

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**Abstract:** The first aim of this study was to contribute to a growing body of research in teacher-student classroom discourse, by describing, in detail, the discourse "moves" of a teacher during science conversations. Our second aim was to develop an enriched analytic framework that can account for the context, the content and the purpose of the discourse moves identified, arguing for a shift of attention in research toward the process of deciding which discourse move to use, rather than solely their description. We analyzed a total of 930 minutes of whole-class conversations facilitated by an experienced science teacher over two years of elementary science lessons. The findings revealed a repertoire of discourse moves that the teacher chose from during instruction based on the context and the epistemological properties of the student discourse content, supporting our contention for the need of a framework that can describe the nature of those choices.

## Introduction

A fast growing body of research in science and other educational contexts has built an interest in classroom-based discourse (e.g., Abell et al, 2000; Carlsen, 1991; Driver et al, 2000; Gallas, 1995; Hogan, 1999; Kelly & Crawford, 1997; Lemke, 1990; Cazden, 2001; Edwards & Mercer, 1987; Edwards & Westgate 1994) for its relevance to student inquiry (Gallas, 1995; Hammer, 1995; van Zee & Minstrell, 1997; van Zee, 2000; van Zee et al, 2001), to the development of student ideas in science (Mortimer, 1998) to student acquisition of cognitive and social skills (Cazden, 1988; Edwards & Mercer, 1987), and to student conceptual change and cognitive development (Adey & Shayer, 1993). Following this current trend in science education research, along with an emphasis to develop rich, detailed case studies of authentic science lessons as a strategy for investigating patterns of talk in authentic science lessons (Chin, 2006; van Zee et al, 2001; Arons, 1983; Roth, 1996; van Zee & Minstrell, 1997; Watt, 1996; Barnes & Todd, 1977), we investigated a science teacher's discourse moves over the course of two years of teaching. Our aim was to provide a detailed picture of the teacher's discourse moves by accounting for the context, the content and the purpose of each teacher move identified as a response to student conversational contributions, as well as, to develop an analytic framework for studying teacher-student classroom discourse in naturalistic science lessons.

## Theoretical framework

### Classroom interaction and discourse in science

The study of teacher-student classroom interaction and discourse has recently received the increasing attention of the educational research community. As a result a number of studies focused on this issue, which revealed a variety of theoretical views about the analysis of discourse that differ in the aspects of discourse that each analytic framework looks into. Thus, suggesting that classroom discourse is by nature a very complex process that includes numerous aspects that one has to take into account.

For instance, Edwards and Mercer (1987) organized their analysis of the classroom-based communicative processes around the extent of the teacher control over the discourse and the content of knowledge, which appears to be a central theme in classroom talk. They identified numerous features of teachers' classroom-based discourse with varying teacher control, but they suggested that teachers often exert tight control over classroom-based discussions even in the cases of hands-on student-centered science activities. Lemke (1990) identified two broad categories of discourse strategies, dialogue and monologue strategies, used by science teachers. Among the most influential features of Lemke's work was the identification of what he found to be the primary mode of classroom discourse. He named it "triadic dialogue," and it typically consists of three moves: (i) teacher initiation of the conversation (often through a teacher question), (ii) student response to the question and (iii) teacher evaluation of that response. According to this framework the teacher asks an information-seeking question, requiring a short answer. After the student response, the teacher praises correct answers and makes corrections to those answers that were incorrect or provide feedback by encouraging students to externalize ideas, generate hypotheses and test them. This framework has been commonly refereed to as the "IRE" framework (Initiation-Response-Evaluation; Mehan, 1979) or the IRF framework (Initiation-

Response-Follow-up or Feedback, Sinclair & Coulthard, 1975; Cazden, 1988) in an effort to highlight that the role of the third move doesn't necessarily need to be an explicit or formal evaluation of the student contribution.

Chin (2006) analyzed classroom-based discourse specifically looking for patterns of teacher questioning and she developed a "questioning-based discourse" analytic framework coding for four aspects of discourse: the student's discourse content, the type of the teacher's utterance (as a response to the preceding student utterance), the student thinking elicited, and the interaction pattern. Chin's study showed that depending on the correctness or not of the student answer, the teachers in the study differentiated their feedback. Orsolinini & Pontecorvo (1992) analyzed a number of small or large group science discussions among students 5 and 6 years of age. Their analysis dealt with the discourse continuity (minimal talk vs. extended talk) and the agreement or disagreement among different speakers. The most frequent categories of teacher's talk was repetition/rephrasing, requests for clarifications and requests for explanations.

Mortimer and Scott's (2003) framework includes two dimensions of classroom discourse: interactive or non interactive discourse as the one dimension, and authoritative or dialogic discourse as the second dimension. In the authoritative discourse the teacher conveys information and his discourse involves questions, statements of facts and reviews, and student utterances are usually given in response to a teacher question and they have limited length. On the other hand, the dialogic discourse supports challenge and debate and it often includes open questions. Student discourse is in many cases spontaneous and consists of longer sentences. Both types of discourse can be interactive and non-interactive, depending on the role of the students.

Van Zee & Minstrell (1997) examined ways of speaking of an experienced teacher that foster the communication of physics principles through "reflective discourse," By in which a student provides statement expressing student's own thoughts, comments and questions and then a teacher asks a question (based on that student statement) that seeks to help students better articulate their ideas, beliefs and conceptions, followed by additional student statements. That definition excludes teacher questions that test student knowledge and the evaluation of correctness of student answers. Rather, in reflective discourse the teacher tries to reflect student thinking back to them providing them space to express their own thoughts in comments and questions. van Zee and Minstrell's (1997) analysis focused on the immediate actions plans that teacher's reflective discourse moves instantiated, the emergent goals they served and the underlying beliefs they embodied. They identified 3 recurrent themes that describe the use of questions by the teacher during reflective discourse: he used questions to help his students (a) make their meanings more clear, (b) consider a variety of views in a neutral manner and (c) monitor the discussion and their own thinking.

In addition to the variety of theoretical views about the analysis of teacher-student classroom discourse shown above, two additional issues emerge from this literature. First, studies applying the IRF framework for analyzing classroom discourse focus more on the structure of the discourse (how a cycle of teacher question and student answers is initiated and maintained). However, other studies (e.g., van Zee & Minstrel, 1997; Chin, 2006; Roth, 1996) suggest that teacher questioning, for instance, is influenced by the content and the context of the discourse, which the IRF cannot describe, because the unit of analysis is teacher question-student answer-teacher feedback. Second, although these studies have revealed a large collection of teacher discourse-based strategies mostly (but not exclusively) for asking questions, they have failed at large to provide a framework that could be useful in both studying teacher discourse, and also helping teachers to prepare for this kind of classroom-based discourse. Following van Zee and Minstrel's (1997) and Chin's (2006) studies we feel that science teacher education community needs to develop better understandings about how teachers respond to their students' contributions, as well as, the discourse moves that may be used in different contents and contexts.

The first aim of this study was to contribute towards this way. Specifically, we aimed to describe the discourse moves of an experienced science teacher as a response to student conversational contributions within a science learning environment. In doing so, we feel that it is vital to our analysis to provide as many details as possible not only about the teacher's discourse moves, but also the context and the content that might have influenced his moment-by-moment decisions. Below, we provide a review of the most frequently used framework for analyzing teacher-student classroom discourse, namely, the IRF framework, and explain why it cannot serve as the framework for contextualizing our study. In particular, we suggest that the IRF structure represents only a small segment of the teacher-student classroom discourse, in which the focus is only on teacher initiation and follow-up in a discussion, whereas, a framework that focuses on student contributions and teacher responses to those contributions in a conversation is needed. By this, we argue for a shift of attention in research towards investigating the process of deciding which discourse move to use, rather than solely their description.

## Analysis of teacher discourse

### The IRF as a framework for analyzing classroom discourse

Lemke's (1990) IRF framework has dominated the research in classroom discourse over the last decade or so (Chin, 2006; Mortimer & Scott, 2003), by becoming the most commonly way of analyzing classroom discourse and therefore investigating teacher questioning as a prominent feature of such classroom talk (Carlsen, 1991; Dillon, 1988; Gall, 1984; Hunkins, 1989). However, IRF framework has received numerous criticisms over the years. First, while there might be some useful features in this framework, it reflects at large traditional approaches to teaching (Cazden, 2001). Viewing teaching through the IRF lens, provides a (traditional) view of teaching that involves moving through a series of questions planned ahead of time (van Zee & Minstrell, 1997), which fit the teacher's agenda. The teacher asks only "display" questions to which she already knows the answer, aiming at testing student knowledge or "co-opting students to participate in what could be otherwise a lecture" (Cazden, 2001, p. 46). The application of the IRF framework in teaching has also restrictive effects on students reasoning, forcing student responses to be short, pitched at the recall or lower-order cognitive level, and teacher-framed (Chin, 2006). Also, it cannot account for adjustments to the teacher's agenda during a conversation, acknowledgment of student contributions in the conversation (in the light of engaging students in taking more responsibility for thinking), or shifting authority for judging students answers from the teacher to the students, in one way of fostering more critical ways of thinking (van Zee & Minstrell, 1997).

Second, despite calls for promoting student inquiry in elementary grades (Hawkins, 1974; NSES, 1996; Minstrell & van Zee, 2000; Osborne et al., 2004; Louca & Hammer, 2007) in contrast to traditional views of simply promoting traditional content in science learning, the application of the IRF framework in science teaching and learning ignores aspects related to student inquiry and developing student abilities for scientific reasoning. As van Zee & Minstrell, (1997) note, inquiry teaching in science involves a rather complex process of adjusting questioning based on the teacher's evaluation of what takes place during the discussion, to accommodate student contributions. However, the F step of the framework focuses on the correctness of the student's answers (thus representing a focus on content) and not on student i.e., abilities for student inquiry.

Thirdly, although this framework can be used for analyzing classroom discourse focusing on the teacher's practices, it ignores the relation of those practices to student discourse. Even in the case of Mortimer &Scott (2003) who suggested a possible expansion of this framework (from IRF to IRFRF) to represent dialogic interactions in the classroom discourse, they still assume that all discourse moves need to be initiated and concluded by the teacher who will be closely eliciting, monitoring and providing feedback to student discourse with no reference to the notion of teacher responses as a follow-up of student discourse (van Zee et al, 2001; Orsolini & Pontecorvo, 1992). Carlsen (1991) has argued that research on classroom-based questioning discourse must acknowledge that the meaning of questions is dependent of their context discourse, that the content of questions cannot be ignored, and that research on questioning has needs to acknowledge that classroom questions are not simply teacher behaviors but mutual constructions of teachers and students.

We do not undervalue the Lemke (1990) framework, since it played an important role in directing research on aspects of classroom-based discourse. However, the IRF structure represents only a small fragment of the teacher-student classroom discourse. Chin (2006) suggested that "future research could look into the differential effect of different types of feedback, the conditions under which different types of feedback are most effective" (p. 1341). We feel that there is much more going on in the classroom than asking questions and evaluating student answers to those questions. Thus, we suggest that instead of having a framework that focuses on teacher initiation and follow-up of a discussion, it might be more productive to have a framework that focuses on the student contributions during the conversation and teacher decisions/responses based on those contributions (van Zee et al, 2001), representing an on-going assessment that "includes monitoring what the students are saying for aspects that may be productive in moving the inquiry forward, even if these differ from scientifically accepted views" (van Zee et al, 2001, p.163). As van Zee & Minstrell (1997) note "analyzing teacher-student-teacher sequences directs attention to the steps by which a teacher moved through a set of ideas associated with a topic. Shifting the unit of analysis one turn, to student-teacher-student sequences, highlights the ways that a teacher's questions influenced student thinking" (p. 230).

## Our Identification – Interpretation/Evaluation – Response Framework (I.IE.R)

Given the need for a more enriched framework for analyzing the teacher-student classroom discourse than the IRF, we propose a new framework that suggests moving from a teacher initiation and follow-up framework, to a framework focusing on student contributions and teacher responses to those contributions. Our framework has a three-part structure, consisting of (i) teacher identification of student contribution (answering to the question "what is the teacher responding to?"), (ii) teacher interpretation and evaluation of their students' contribution and (iii) teacher response to their students' contribution ("how is the teacher responding?"). Our framework is concerned with how teachers perceive student contributions in a conversation in science, how they evaluate them and how they respond to those contributions. We do not narrow teacher actions and responses only to questions, but we seek to broaden the framework to account for teacher prompts, clarifications, evaluations and restatements of student contributions. Additionally, we take student contributions to include not only knowledge claims and ideas, but also student reasoning and inquiry, student epistemologies, and student's use of empirical data and everyday experiences to support their ideas, thus making the framework more student-centered to account for the complexity of the regular science classroom, following research suggesting that the role of science teachers should be viewed as supporting student inquiry (i.e., Hammer 1995) and student sense making in the science classroom (i.e., Scott, 1998).

## Methodology

This is a qualitative case study documenting ways of speaking (Hymes, 1972; Hymes & Farr, 1982; Philipsen, 1982; 1992) of a particular teacher in a particular context (van Zee & Minstrell, 1997). We investigated the discourse moves of a male teacher in science lessons over the course of two years of once-a-week lessons. The selection of the teacher was based on three reasons: (a) his substantial experience in teaching science in elementary schools (13 years), (b) his educational background (doctoral student) and (c) he was identified as one of the exemplary teachers by the school district.

The study involved two groups of students, one group per year, at a metropolitan elementary school in Cyprus. The first group involved 5 fifth graders and 4 sixth graders (year 1), whereas, the second group involved 4 fifth graders and 7 sixth graders. During each year, we set up an afternoon computer/science club, and students volunteered to participate in the study. Students (10-12 years olds) met with the same teacher once a week for 90 minutes for a total of 7 months, during which they studied a number of physical phenomena. From a total of 47 lessons videotaped (24 during the first year and 23 during the second year), 32 (16 per year) were spent studying physical phenomena (a total of 1920 minutes of classroom work). For this study, we purposefully selected and fully transcribed whole class conversations from all teaching sessions as the primary data source. A total of 930 minutes of student conversations facilitated by the teacher were analyzed.

For the purposes of this study, we analyzed discourse data using our proposed I-IE-R framework. However, due to space limitations, in this paper we report findings only for the "I" and "R" part of our I-IE-R framework because they are the only parts that could be directly derived from the analysis of transcript. The "IE" part is not a process that we can code for from the transcript, but a mental process that we can only see its results (the "R" part of the framework). In a different paper we discuss data collected from a number of interviews with the teacher that provide insights to the IE process. Following Chin's (2006) study, we developed a coding scheme for 3 aspects of classroom discourse that are relevant to the I-IE-R framework: (a) what did the teacher respond to (coding for student contribution(s) that the teacher responded to), seeking to account for the "I" part of the analytic framework, and (b) how did the teacher respond. The latter two were used to account for the "R" part of our analytic framework. Working from the transcript we isolated each teacher utterance and the first two authors investigated its immediate before and after context, trying to reach a consensus as to what was the teacher responding to and how he responded to what he was identifying (both in terms of type of discourse used and the content of its response). Starting from the literature we identified a number of different areas for each of the three discourse elements that we intent to code for. Then, in many reiterative cycles of interpretation we discussed our emerging codings and made adjustments following open coding (Strauss & Corbin, 1998). Our unit of analysis was the I-IE-R "exchange" which included the preceding discourse that the teacher was responding to, and his immediately response. After finalizing our coding scheme, coding was carried out by the first two authors independently (Cohen's Kappa=0.835), and differences in the assigned codes were resolved through discussion. We then presented findings to the teacher in the context of an informal interview, as a participant check.

## Findings

### What did the teacher respond to?

The first aspect of the teacher discourse codes for what the teacher responded to ("I" part the I-IE-R framework). This required close inspection of the utterances preceding each teacher "move", as well as the teacher response and then try to reach intercoder agreement on which of those aspects the teacher responded. Therefore, the first aspect of our framework identifies which part of the student conversational contribution the teacher responded to.

Following the attention of current trends in science education research (Louca & Zacharia, 2007; May et al, 2006; Russ, 2006), our final coding scheme includes five different areas (see Table 1) that account for the all the types of student contributions we have identified in the conversations analyzed, and beyond of traditional views that focus solely on scientific knowledge (content), to include issues related with student scientific reasoning and logic, the nature of the science and logistical issues related with the management of the conversation. Those five areas include: (i) knowledge claims (73,4% of the total utterances coded), (ii) scientific reasoning and logic (5,6%), (iii) everyday experiences (5,9%), (iv) epistemologies (0,7%), and (v) the direction of the conversation (14,1%).

By knowledge claims we refer to conversational elements that are directly related with the content (that is, the knowledge) of the conversation, similar to what Mortimer & Scott (2000) suggest and to what Chi (2006) has included in her coding scheme. However, we have expanded this category to differentiate among different conversational elements that may fall under the knowledge claims category. Almost half of the teacher's responses addressed scientifically accepted knowledge claims (49,7% of the total coded utterances, or 67,8% of the utterances coded under knowledge claims), whereas 11,1% of his total responses (or 15,1% of the utterances coded under knowledge claims) addressed non-scientifically accepted knowledge claims. 7,6% of the total teacher's responses (or 10,4% of the utterances coded under knowledge claims) were invoked by the emergence (or presence) of a number different knowledge claims in the conversation offered by different students. 2,8% of his total responses (or 3,8% of the utterances coded under knowledge claims) seemed to have been invoked by a student changing a previously stated idea, and 2,2% of the total teacher responses (or 3,0% of the utterances coded under knowledge claims) followed a student question regarding a knowledge claim.

As far as the teacher's responses to students' scientific reasoning and logic (5,6%) is concerned, they were differentiated based on what David Hammer calls a hidden assumption underlying student ideas offered in the conversation (3,1% of the total utterances coded or 55,9% of the utterances coded under reasoning and logic), scientifically accepted use of analogies (0,2% and 3,4% respectfully), non-scientifically accepted use of analogies (0,2% and 3,4% respectfully) (May et al, 2006), student claims for a dependency related to the phenomenon under study (0,4% and 6,8% respectfully), students providing grounds for a previously stated dependency or knowledge claim (0,7% and 11,8% respectfully), and grounds for knowledge claims (1,0% and 18,6% respectfully).

Table 1. Different elements of the classroom discourse that the teacher responded to.

| | | |
|---|---|---|
| Knowledge Claims (73.4%) | Scientifically accepted knowledge claim | 49.7% |
| | Non- scientifically accepted knowledge claim | 11.1% |
| | A student changes her knowledge claim | 2.8% |
| | A student question regarding a knowledge claim | 2.2% |
| | Different students present different knowledge claims | 7.6% |
| Logic & Reasoning (5.6%) | Hidden assumption | 3.1% |
| | Scientifically accepted use of an analogy | 0.2% |
| | Non-scientifically accepted use of an analogy | 0.2% |
| | Students offering a claim for a dependency | 0.4% |
| | Students offering grounds for a dependency or knowledge claim | 0.7% |
| | Students offering grounds for a knowledge claim | 1.0% |
| Experiences (5.9%) | Experiences from everyday life related to the phenomenon under study | 2.8% |
| | Lack of experience related to the phenomenon under study | 3.1% |
| Logistical issues of the conversation (14.1%) | A student changes the direction of the conversation | 2.6% |
| | The teacher begins a conversation about a new topic | 8.8% |
| | A student asks a question regarding the topic of the conversation | 2.7% |
| Epistemologies (0.7%) | A student asks a question about the kind/form of the answer that the teacher expected (i.e., an example, a theory, a mathematical example) | 0.3% |
| | Lack of understanding the differences among contradicting knowledge claims offered in the conversation | 0.4% |

In terms of his responses to students' experience (6,3% of total utterances coded), 2,8% of the total utterances coded (or 43,9% of the utterances that fell under experiences) were teacher responses to everyday life experience appropriately related to the phenomenon under study that students shared in during the conversation. 0,4% of the total utterances coded (or 6,1% of the utterances that fell under experiences) were responses to experiences offered in the conversation inappropriately related the phenomenon under study, and 3,1% were responses to the lack of use of any experience related to the phenomenon under study to the conversation.

Most of the cases that fell under his responses regarding logistical issues related to the discussion (14% of the total utterances coded) were associated with the teacher beginning a new topic for conversation (8,8% of the total utterances coded or 62,6% of the utterances that fell under logistical issues of the conversation). 2,6% of the total utterances coded (or 18,4% of the utterances of this category) addressed a change in the direction of the conversation caused by students' contributions whereas 2,7% of the total utterances coded (or 19% of the utterances of this category) addressed a student's question related to the topic of the conversation.

Lastly, 0,7% of the teacher's responses addressed issues related to epistemology. In particular, the teacher responded to a student question about the kind or form of the answer that the teacher expected from students (0,3% of the total coded utterances or 42,9% of the utterances coded under epistemology) or the lack of students' understanding about the differences among contradicting knowledge claims already offered in the conversation (0,4% or 57,1% respectfully).

## How did the teacher respond?

Although research in student-teacher discourse in science has for some time now called attention on a number of different aspects of the discourse, a large part of research in educational settings has focused on the kinds and characteristics of teacher questions during (science) instruction. We feel that there is much more going on in the conversation in terms of what the teacher does than solely asking questions. Starting from the literature (van Zee & Minstrel, 1997; van Zee et al, 2001; Edwards & Mercer, 1987) we identified a number of different ways for responding in the classroom, and then through open coding we developed new codes and a structure for the different types of teacher actions during the conversations analyzed ("R" part the I-IE-R framework). Our expanded coded scheme includes four major categories of teacher actions (see Table 2): (1) prompting (61,6%), (2) making clarifications (17%), (3) evaluating student ideas or reasoning (2,3%) and (4) restating student ideas (19,1%) (or as Edwards & Mercer (1987) suggest, paraphrastic interpretation of student contribution).

Table 2. The teacher discourse moves.

| | | | |
|---|---|---|---|
| Prompts for (61.6%) | Knowledge Claims (38.3%) | ask students for ideas (open ended) | 10.8% |
| | | ask students for ideas (non-open ended) | 13.5% |
| | | ask students for justifications of their ideas | 14.0% |
| | Reasoning (22.1%) | ask students to evaluate different ideas | 3.7% |
| | | ask students to infer relationships among various ideas | 3.5% |
| | | ask students to engage in argumentation | 5.5% |
| | | ask students for explanations | 9.4% |
| | Experiences | | 1.2% |
| Make clarifications about (17%) | The topic under study | | 7.3% |
| | Reasoning (1.1%) | similarities among knowledge claims | 1.0% |
| | | Claims for "dependencies" | 0.1% |
| | Students' experiences | | 1.2% |
| | The direction of the conversation | | 6.1% |
| | Students' epistemologies | | 1.1% |
| Evaluate students' ideas or reasoning | | | 2.3% |
| Restate student ideas or reasoning | | | 19.0% |

The coding scheme for teacher prompting (61,6%) (or as Edwards and Mercer (1987) put it elicitation of student responses) includes a number of different conversational elements. He prompted for student ideas about a situation/phenomenon in an open-ended manner (10,8% of the total utterances coded or 17,5% of the utterances that fell under prompts), or asked a question requiring a short and specific answer (13,5% and 21,8% respectfully). Additionally, the teacher called for clarifications of a previously stated idea (van Zee & Minstrell, 1997) or reasoning knowledge claims (14% or 22,8% respectfully), for evaluation of student contributions in the conversation (3,7% or 6,0% respectfully), for drawing connections among different contributions (3,5% or 5,7% respectfully), and for engaging in argumentation (5,5% or 9% respectfully). He also prompted for the development of explanations about a previously stated idea or reasoning (9,4% or 15,2% respectfully), and for (additional) experiences (van Zee et al, 2001) that could support student ideas about the phenomenon under study or their reasoning (1,2% or 2% respectfully).

Teacher clarifications (17%) also cover a spectrum of different things that include clarifications about student knowledge claims (content) (7,3% of the total utterances coded or 43,3% of utterances coded as clarifications), about similarities or differences among knowledge claims (1% or 6,2% respectfully), and claims about the dependencies related to the phenomenon under study suggested by the students (0.1% or 0.6% respectfully). Regarding experiences, 1,2% of the teacher's actions (or 7,3% of his actions coded as clarifications) were related to examples offered in the conversation and their possible relations with the phenomenon under study. Regarding clarifications about logistical issues related to the discussion, 6,1% (or 36% respectfully) of the teacher actions were clarifications about the direction of the conversation. Lastly, 2,3% or (6,7% respectfully) of his clarifications were addressing epistemological aspects of the student discourse in the form of clarifications about the kind or the form of the answer that he expected from the students.

## Discussion & Conclusions

By combining the findings from the two coding schemes, a number of instructional moves were revealed. For instance, when the teacher responded to student questions about knowledge claims, he re-addressed them to the whole class, without giving any answers directly or dismissing any student question. Additionally, when students provided scientifically incorrect knowledge claims (ideas), the teacher did not evaluate them himself, but rather he steered the student conversation towards evaluating those ideas and focused, primarily, on identifying and addressing the flaws of students' reasoning rather their ideas. During the informal interview, the teacher clarified that he used this strategy when he sensed that the students were not simply stating an incorrect idea, but rather they reached incorrect conclusions through flowed reasoning. He further explained that by addressing this kind of student reasoning, he hoped to help students resolve the issue. Further, when the teacher responded to knowledge claims (73,4%), he prompted (43,7%) or less often made clarifications (29,7%) that were related to the knowledge claims. Additionally, the teacher seemed not to respond differently to correct or incorrect knowledge claims, whereas he differentiated the responses between correct (0,2%) or incorrect elements of student reasoning (0,2%). When he responded to his students' reasoning (5,6%) or experiences (6,3%), the teacher seemed not to follow a dominant strategy: he prompted or made clarifications related to knowledge claims, students' reasoning, experiences, epistemologies and direction of the conversation. His responses to correct reasoning were divided between prompts for reasoning (0,1%) and clarifications for the direction of the conversation (0,1%), whereas his responses to incorrect reasoning were divided between making clarifications for the topic under study (0,1%) and students' experiences (0,1%). We will present details of the relationships between what the teacher was identifying in terms of student inquiry and how he responded, as well as, short snippets of student-teacher interaction to ground our claims.

Overall, the teacher's profile revealed a large repertoire of discourse moves that the teacher chose from during instruction. Their use appeared to depend on the context and the epistemological properties of the content of the student discourse, showing sophistication in identifying and evaluating student contributions in the conversation prior to any instructional response. In different situations (i.e., correct or incorrect knowledge claims or reasoning) he used a different discourse move based on the content and the context of the student utterance he responded to.

Findings from this study have two major implications for research and teaching. First, the revealed repertoire of discourse moves, along with other research indicating that there is more going on in teacher discourse than simple questions (Roth 1996; van Zee & Minstrel, 1997; Chin, 2006; Cazden, 2001), supports our suggested need for more detailed investigations of teacher-student classroom discourse. Research in teacher and student discourse needs to use analytic frameworks that can describe the nature of teacher minute-by-minute choices. To do that, the content of the student contribution, its context need to be take under account, as well as the content of the teacher response, its characteristics and the rational of the decision for using one response over another. We feel that our proposed framework may help move research towards that direction, from a teacher initiation and follow-up framework, to a framework focusing on student contributions and teacher responses to those contributions. Our framework is concerned with how teachers perceive student contributions in a conversation in science, how they evaluate them and how they respond to those contributions. We do not narrow teacher actions and responses only to questions, but we seek to account for teacher prompts, clarifications, evaluations and restatements of student contributions. Additionally, we take student contributions to include not only knowledge claims and ideas, but also student reasoning and inquiry, student epistemologies, and student's use of empirical data and everyday experiences to support their ideas.

Secondly, assessing student conversational contributions during class is a challenging work because it requires that the teacher identifies, interprets and evaluates his students' scientific inquiry before responding. Teachers have very limited time to make such judgments, and thus they need to develop their in-class "instincts" for responding to their students' reasoning. Findings from studies like the one we describe in this paper could be used as the basis for designing professional development courses that can help teachers develop their in class "instincts," about what they should be looking for in terms of their students' scientific inquiry and how they should respond in an attempt to scaffold their students' scientific inquiry.

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## Acknowledgments

This study was partly supported by the Cyprus Research Promotion Foundation Awards ΕΝΙΣΧ/0505/44.