Middle school science students’ dialogic argumentation

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Abstract. Argumentation schemes for presumptive reasoning are used to analyze students’ small group discourse during the evaluation of a science investigation project. Seventeen triads of middle school students participated in a structured 45-60 minute long interview. The broad set argumentation schemes employed by students, such as argument from sign and argument from consequences, suggests that the authentic argumentative practices of students reflect a blending of analytical, dialectical and rhetorical devices. The data suggest that a developmental corridor for argumentation would begin with the dialectical structures/patterns and build toward the analytical structures/patterns. Students in the treatment groups employed more argumentation schemes for requesting/critiquing evidence and for drawing inferences from claims.

Objective/Purpose. Quality teaching involves providing quality feedback to learners. An area of feedback that is not well understood is assisting novice science learners with arguing from evidence to explanation, or more generally, from premises to conclusions. Given that the language of science involves both the evaluation and justification of knowledge claims, argumentation strategies are recognized as (1) an important tool for doing and talking science and (2) as a generic strategy for developing rational thinking and promoting democratic discourse. There are two purposes for the presentation. One is to introduce a new methodological approach – argumentation schemes for presumptive reasoning - teachers and researchers can employ to understand the argumentation strategies employed by learners. Two is to report the results of an experimental study that employed the new methodological approach to analyze small group (n=3) discourse.

Theoretical Framework. Argumentation has three generally recognized forms: analytical, dialectical, and rhetorical (van Eemeren et al, 1996). Analytical arguments are grounded in the theory of logic and include, as examples, material implications, syllogisms and fallacies. Essentially in the analytical approach an argument proceeds inductively or deductively from a set of premises to a conclusion. Dialectical arguments are those that occur during discussion or debate and involve reasoning with premises that are not evidently true. Dialectical arguments are a part of the informal logic domain. Rhetorical arguments are oratorical in nature and are represented by the discursive techniques employed to persuade an audience. In contrast to the other two forms of argument where the evidence is paramount, rhetorical arguments stress knowledge of audience. Designing learning environments to facilitate and promote argumentation is a complex problem given that the discourse of science involves three different forms of argumentation. The central role of argumentation in doing science is supported by both psychologists (Kuhn, 1993) and philosophers of science (Siegel, 1995) as well as science education researchers studying the discourse patterns of reasoning in science contexts (Driver, Newton & Osborne, in press; Kelly, Chen, & Crawford, 1998; Lemke, 1990). Argumentation is seen as a reasoning strategy and thus also comes under the general reasoning domains of informal logic and critical thinking as well. Driver and Newton assert that we have much to learn about the dynamics of argumentation in science classrooms. To date, most investigations of student discourse in science have relied on the application of analytical forms of arguments (Kuhn, 1993) or Toulmin’s model for practical arguments (Eichinger, Anderson, Palincsar & David, 1991; Pontecorvo & Girardet, 1993; Kelley, Chen, & Crawford, 1998). In these studies,
emphasis is placed on the structural features of arguments (i.e., premises, initial conditions, warrants, backings) and the empirical evidence presented to or employed by learners. Other promising approaches for studying discourse have used linguistic theory to analyze science talk (c.f., Gee, 1994; Lemke, 1990). A yet to be explored alternative avenue is that of employing dialogue logic to the analysis of argumentation discourse in science classrooms. Dialog logic occurs during dialectical argumentative exchanges, like that which occurs during collaborative small group science investigations, assessment conversations (author, 1997) and asynchronous computer-supported communication environments. Driver, Newton and Osborne (in press) maintain an important application of understanding the role and function of argumentation is to study the argumentation discourse of group work in science classrooms. During a dialog a proponent may carry any number of changing commitments as the burden of proof shifts during an exchange. In a dialogue context, the sources of evidence employed to shift burden of proof are much more extensive than those employed in analytical contexts. Rescher (1976), and more recently Walton (1996), maintain that dialectical argumentation is grounded in burden of proof, presumption and plausibility. Walton defines presumptive reasoning as that reasoning which occurs during a dialog when a course of action must be taken and all the needed evidence is not available. Such reasoning is not based solely on knowledge and probability and instead focuses on shifting presumption onto the other dialogue participants. Such a scenario of reasoning from a partial set of experiences and evidence reflects quite well what typically occurs in middle school science classrooms. The present study investigated how effective a set of argumentation schemes for presumptive reasoning are at capturing and representing the argumentation strategies used by middle school science learners.

**Design & Procedures.** Seventeen triads of middle school students participated in a structured 45-60 minute long interview. The task for the group was to review and then provide constructive feedback for the improvement of a science fair project. Interview protocols were designed, reviewed, piloted and revised. There were three components of the interview: first, a warm-up activity that involved students cooperatively constructing tangram figures, second, a set of open-ended questions focusing on the format and content of the science fair project and third, a set of questions focusing on the evidence and the claims made in the science fair project. All sessions were video-taped and audio-taped and then transcribed. Transcripts of the sessions were reviewed for accuracy. The present study only examines the last, or third section of the structured group interview. Eight of the 25 argumentation schemes proposed by Walton were selected for the second analysis. Given the emphasis on dialog, the unit of analysis was the reasoning sequence. The reasoning sequences is the conversation that takes place between group members when debating or arguing for, or against, a specific course of action or when evaluating a particular claim.

**Results/Conclusions.** In contrast to the success Pontecorvo and Girardet (1993) had with applying Toulmin’s argument pattern to analyze group reasoning in a history context, we found that the analysis of discourse employing argumentative and epistemic operations did not adequately distinguish signal from noise. Consequently, distinguishing the structure and patterns of argument was difficult. Difficulties were also encountered with the assignment and analysis of epistemic operations. The dialectical nature of the group interview made the assignment of analytic epistemic operations like definition, categorization, predication, evaluation, warrants and backings awkward. At times it felt as if square pegs were being forced into round holes. There was more success at assigning the epistemic operations to the reasoning sequences than to the idea units. A search of the literature on argu-
mentation led to the discovery of Walton’s (1996) Argumentation Schemes for Presumptive Reasoning. The use of Walton’s presumptive reasoning schemes more adequately fit the dialectical structure, reasoning sequences, of the group interview. The broad set argumentation schemes employed by students, such as argument from sign and argument from consequences, suggests that the authentic argumentative practices of students reflect a blending of analytical, dialectical and rhetorical devices. The data suggest that a developmental corridor for argumentation would begin with the dialectical structures/patterns and build toward the analytical structures/patterns. With respect to the experimental study, frequency counts of argumentative schemes between treatment groups (students completing SEPIA curriculum) and control groups (non-SEPIA students completing process curriculum) were significantly different in favor of the treatment group. Students in the treatment groups employed more argumentation schemes for requesting/critiquing evidence and for drawing inferences from claims.

**Educational Significance.** The broad set of argumentation schemes employed by students, such as argument from sign and argument from consequences, suggests that the authentic argumentative practices of students reflect a blending of analytical, dialectical and rhetorical devices. The data suggest that a developmental corridor for argumentation would begin with the dialectical structures/patterns and build toward the analytical structures/patterns. The analysis employing the Walton scheme demonstrates that individuals bring a great deal more to argumentation than are identified by strict analytical logical schemes. Presumptive reasoning analyses seem to be a natural entry point for the assessment and development of student’s argumentation strategies. Creating contexts and facilitating discourse that promote effective argumentation is a poorly understood element of science instruction. Augmentation of student’s discourse to promote critical thinking and reasoning would benefit by a shift from an emphasis on deductive and inductive argumentation schemes to an initial emphasis on the more natural dialog logic found in dialectical contexts.