

Uncertainty Management in Science Argumentation

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Abstract: The purpose of this study is to investigate how an experienced 5th grade teacher helps students approach and manage uncertainty during scientific argumentation. Transcripts of nineteen lessons over the course of the school year were analyzed using the constant comparative method and the enumerative approach and were coded for social negotiation and epistemic engagement of an argument. Results include that over time the dialogic move gradually shifted from teacher-directed to a more student-directed pathway.

Keywords: Argumentation, uncertainty, social negotiation, epistemic engagement, inquiry

Introduction

Argumentation has recently been advocated a critical need for science education (e.g., National Research Council [NRC], 2012) because it helps students learn to discern what counts as good evidence, manage uncertainties, and reach consensus through dialogic negotiation (Berland & Lee, 2012; Buck, Lee, & Flores, 2014). *A Framework for K-12 Science Education* states: “Scientific knowledge is a particular kind of knowledge with its own sources, justifications, ways of dealing with uncertainties, and agreed-on levels of certainty (NRC, 2012).” However, engaging students in dealing with uncertainty through argumentative practice is ambitious and challenging. Transferring this unique form of practice from expert settings to classrooms is not unproblematic (Watkins, Hammer, Radoff, Jaber, & Phillips, in press); understandably, the intentions and ways that scientists work are not familiar to students.

Uncertainty is defined as “an individual’s subjective experience of doubting, being unsure, or wondering,” and experiencing uncertainty “likely plays an important role in content learning and in interaction during collaborative learning tasks.” (Jordan & McDaniel, 2014). This study aims to unpack and track how an experienced teacher engages fifth-grade students in dealing with uncertainties over the course of a school year. Previous research on uncertainty during the development of scientific understanding has focused on the experiences of individual students (e.g., Chen, Park, & Hand, 2016; Metz, 2004) or small groups (e.g., Jordan & McDaniel, 2014) rather than of the class as a whole. This study aims to add to the body of knowledge regarding uncertainty during argumentation by considering the social negotiation and epistemic engagement of an argument that take place during whole-class argumentation.

Methods

The Science Talk Writing Heuristic (STWH) approach (Chen, Benus, & Yarker, 2016) was utilized to create curriculum and instructional strategies that promote building disciplinary core ideas while using talk and writing to engage students in scientific practices. The STWH approach consists of five phases: (1) exploring beginning ideas/generating an inquiry question, (2) designing tests/observations to gather data, (3) engaging in social negotiation to debate claim/evidence, (4) reading to compare ideas with experts, and (5) reflecting through writing. Given the purpose of this study, i.e., how a teacher helps students engage in managing uncertainties through social negotiation, the analysis focused on the third phase.

Nineteen classroom observations of whole-class discussions were purposefully selected over four units—ecosystem (six classes), human body system (six classes), day and night (three classes), forces and motion (four classes). Each unit had the same overall structure, starting with a “big idea” to guide students’ questions, investigations, and whole-class discussions that occurred after students designed and conducted experiments to answer their guiding question about the “big idea” (Chen, Hand, & Park, 2016).

The analysis of the nineteen classes involved two complementary analytical approaches: (1) the constant comparative method (Strauss & Corbin, 1990) and (2) the enumerative approach (LeCompte & Preissle, 1993). All nineteen classroom observations were transcribed and each transcript was broken into individual utterances, defined as an idea that contributed to the discussion. Because this study is particularly interested in how teacher and students use social negotiation (e.g., collaboratively construct and critique arguments to build consensus) and epistemic engagement of an argument (e.g., understand what counts as a good argument and apply that understanding to argumentation) as resources to manage uncertainties (Duschl, 2008), each utterance was coded for both social negotiation and epistemic engagement. Figure 1 shows the coding scheme as applied to one event in the sixth transcript of the first unit (ecosystem), in which one group of students stated their claim about the

effect of temperature on the germination of seeds to the rest of the class, and the teacher raised uncertainty by asking the group to clarify their claim. The resulting discussion involved social negotiation and epistemic engagement of an argument by both teacher and students, at the end of which the group restated their claim.

Transcript 01, Event #6 – Temperature Group presents their claim

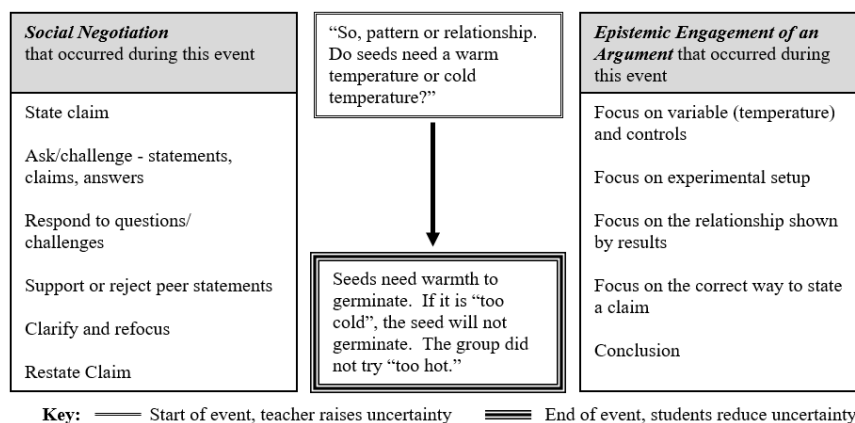


Figure 1. Event map from the ecosystem unit showing the social negotiation and epistemic engagement of an argument components of a teacher-directed dialogic pathway (see Results, below).

Results

Three dialogic pathways have been identified through analyzing each event: (1) teacher-directed pathway: teacher raises an uncertainty, guides and intervenes to maintain the uncertainty through engaging students to evaluate and improve their arguments, and resolve the uncertainty resulting in the group reaching a consensus, (2) serpentine pathway: teacher or students raise an uncertainty, teacher and students cooperate together to maintain and resolve uncertainty, and (3) students-directed pathway: students raise an uncertainty, maintain an uncertainty through comprehending, constructing and critiquing the argument, and eventually resolve the uncertainty. As the semester proceeded with increasing opportunities for students to engage in uncertainty management, the dialogic moves shift from teacher-directed to serpentine and student-directed pathway. Students started to learn how to raise, maintain, and resolve uncertainty.

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