Advancing Epistemological Frame Analysis to Refine Our Understanding of Inquiry Frames in Early Elementary Interviews

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Abstract: The present study contributes to our understanding, and the methods for measuring, students' epistemological framing in the context of thirty first- and second-graders learning about complex systems. Our goal was to automate the process of identifying frames by coding behaviors and then determining whether they cluster around specific researcher identified frames. We developed a dual-layered coding scheme of the video recordings from semi-structured interviews and a Bayesian model to provide validity warrants to our analyses.

Research has shown that the way students interpret an activity such as a cognitive interview will shape how they will respond, explore, and learn within the activity (Russ, Lee, & Sherin, 2012). Of particular importance are the expectations that students develop for how they are to engage with knowledge in a given situation. These expectations, called "epistemological frames" (Scherr & Hammer, 2009) have, for example, been shown to influence whether students who are asked about something they don't know will simply state that they don't know or actively attempt to explore and identify a valid answer. Traditionally, students' epistemologies are measured through self-report, and as a result do not always provide accurate information about their epistemological stance as it relates to the contexts in which they are learning (Scherr & Hammer, 2009). Therefore, epistemological frame analysis has been developed to analyze this contextual dependency of students' expectations with respect to knowledge. This method studies the interaction between students' framing, behavior, and the content of their speech and has been used to describe the relationship between students' frames and the way they engage with learning activities at the middle school through college level.

In this paper we aim to build upon this work in two key ways. First, we will explore the association between students' framing, behaviors, and the substance of their thinking with early elementary students learning about complex systems concepts such as emergence (Jacobson & Wilensky, 2006), in the context of a semi-structured interview about bees collecting nectar (Danish, Saleh & Andrade-Lotero, 2014). Exploring the utility of frame analysis in this new context will provide insight into how to evaluate interview data with younger children, and any unique challenges that working with young children introduces will further refine the theory and practice of using frames to answer questions about student knowledge and learning. Second, we are attempting to refine the methodological toolkit used to identify frames in an effort to develop a more consistent measurement approach. Specifically, we explore the potential for using a Bayesian analysis to identify whether clusters of observable behaviors can be used to predict researcher-interpreted frames in rich video data of student interviews.

Conceptual Framework

Learning scientists have increasingly paid more attention to how students understand what kind of learning activity they think they are in (Greeno, 2009). For instance, researchers focus their attention on students' expectations of what knowledge, reasoning, and learning in a particular discipline entails (Hammer, Elby, Scherr, & Redish, 2005). Frames have been defined as a pragmatic meta-message of 'what is going on' in people's moment-by-moment interactions (Bateson, 1955). These context-based epistemic units organize our behaviors with respect to the way we interpret the world as well as other's behaviors. When students engage in a new activity, their prior expectations would guide their framing differently, and in such a way it may be more or less productive for the instructional goals of the learning activity (Hutchison & Hammer, 2010). In this particular study, we want to see how students' framing of the interview context influences their engagement with the content (complex systems concepts) being discussed. Specifically, building on Russ (Russ et al., 2012), we believe that an inquiry frame will involve students re-examining their assumptions and thus reaching new conclusions whereas an examination frame will lead to terse answers and little additional learning.

Research Design

The analysis that follows is based on a secondary analysis of data collected in the spring of 2012 (Danish et al., 2014). Thirty first- and second-graders (6-7 years old) took part in this study. The purpose was to support students' learning of complex systems by scaffolding a computer simulation about bees with inquiry prompts. Individual semi-structured interviews were conducted as a post-test to obtain evidence for the students' level

of understanding of complex systems. During the interview, students were asked questions about the behavior of bees as a measure of direct learning. For instance, children saw the picture of a beehive and a flower with nectar and explained what they thought the bees would do. Video recordings were obtained from both the intervention and the interview. In the present study we focused our analysis on the video-recordings of the interviews. We divided each video excerpt in a sequence of 10sec segments. We consider a 10sec segment long enough to include sufficient information about the behavior, yet short enough to provide sufficient discrete data points for our statistical analysis.

Prior examinations of students' frames have involved having multiple researchers code all of the student behaviors and then attempt to interpret students' frames through repeated watching of the video data. Our goal was to extend this approach in a manner that would more consistently map easily observed behaviors to frames, and potentially find shifts in frame at a finer-grained level of detail while adding the ability to report the statistical validity of the approach. Generally speaking, our approach involves using a sub-set of researcher- identified frames to establish a statistical model for which behaviors identify which frame, and then to vet whether we can use the behaviors to predict frames and frame transitions in the remainder of the data corpus. Therefore, we developed what we called a dual-layered coding scheme. The first layer comprises a series of lines of codes, one per observable feature. Grounding our codes on Russ et al. (2012) study, we coded five different features: a) body leaning, b) gaze, c) hand gesturing, d) hedging, e) volume and clarity of speech. For the second layer, we coded 25% of the video to identify researchers' interpretation of how students were framing the activity. We regard this interpretative set of codes as the 'training' set, from which the proportion and particular combination of observable features provide the basis for the automatized coding for the rest of the video. The algorithm employed was a Bayesian multilevel multinomial logistic regression to account for the nested structure of the data. We propose that discrepancies between interpreted and predicted clusters would provide empirical validity evidence for the inferences we make about students' epistemological framing. We also include evidence of external relations between our data and performance measures of student presentation of complex systems concepts on the interview questions.

Findings and Conclusions

Our results indicate that we were able to use body, gaze, hand gesture, hedging behaviors, volume and clarity of speech to make predictions about whether students were engaging in specific frames as defined by Russ et al. (2012). This project aims to extend prior approaches to the analysis of epistemological framing and further refine our understanding of inquiry frames during interviews. Results can support researchers in intentionally designing to support those frames, such as inquiry, which support children's active exploration for answers. Our approach to using statistical models also provides new ways to include validity warrants in researchers' selection of observable features which guide their interpretations, and to increase reliability of characterizing students' frames.

References

Bateson, Gregory. (1955). A theory of play and fantasy. *Psychiatric research reports, 2*(39), 39-51.

Danish, J. A., Saleh, A., & Andrade-Lotero, L. A. (2014). Software Scaffolds for Supporting Teacher-Led Inquiry into Complex Systems Concepts. Paper presented at the AERA annual meeting, Philadelphia, PA.

Greeno, James G. (2009). A theory bite on contextualizing, framing, and positioning: A companion to Son and Goldstone. *Cognition and Instruction, 27*(3), 269-275.

Hammer, David, Elby, Andrew, Scherr, Rachel E, & Redish, Edward F. (2005). Resources, framing, and transfer. *Transfer of learning from a modern multidisciplinary perspective*, 89-120.

Hutchison, Paul, & Hammer, David. (2010). Attending to student epistemological framing in a science classroom. *Science Education, 94*(3), 506-524.

Jacobson, Michael J, & Wilensky, Uri. (2006). Complex systems in education: Scientific and educational importance and implications for the learning sciences. *The Journal of the Learning Sciences, 15*(1), 11-34.

Kruschke, John. (2010). *Doing Bayesian Data Analysis: A Tutorial Introduction with R*: Academic Press.

Russ, R.S., Lee, Victor R, & Sherin, Bruce L. (2012). Framing in cognitive clinical interviews about intuitive science knowledge: Dynamic student understandings of the discourse interaction. *Science Education,96*(4), 573-599.

Scherr, R.E., & Hammer, D. (2009). Student behavior and epistemological framing: Examples from collaborative active-learning activities in physics. *Cognition and Instruction, 27*(2), 147-174.

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