Between the Lines: The Role of Curriculum Materials and Teacher Language in Communicating Ideas about Scientific Modeling

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Abstract: This poster examines the extent to which teacher language is supported by innovative curriculum materials to engage students in a degree of authentic science practice, specifically looking at lessons which integrate model-based activities. Our findings describe patterns in teacher language during explicit metamodeling instruction, and also describes the ways in which this language appears to be supported by the science curriculum.

Introduction

Innovative, reform-based curriculum materials, such as the project-based materials used in this study, have been developed which reflect the changing needs of society and mirror the work of scientists by integrating instruction of content with scientific practices. One such practice that has been incorporated into these new curricular materials due to both its central role in science work, and it's more prominent role in new reform documents (e.g., NRC, 2012), is developing and using models to advance questions and explanations and to communicate ideas. We know teachers find it challenging to incorporate model-based instruction into their practice (e.g., Windschitl et al., 2008). What is less clear is, if provided the support of reform-based curriculum materials, of which scientific modeling is an integral aspect, whether teachers have the language around which to engage their students in science learning that mirrors authentic science work. Classroom discourse, specifically, the language teachers use to communicate science content, provides the context through which students formulate their own ideas, and is significant for the meaning it can convey to students not just about science content, but also about the nature of science and science practices (Zeidler & Lederman, 1989). Thus, this analysis examines whether teacher language is supported by innovative curriculum materials to engage students in a degree of authentic science practice, specifically looking at a lesson which integrates a model-based activity.

Theoretical Framework

Framing this study is the idea that science learning consists of participation in practice (Lave, 1991), and teacher language is an important tool for socializing students into science learning (Gee, 2004). The social interaction between students and a more knowledgeable other, such as a teacher, is crucial to the acquisition of scientific meaning, which is communicated by, and derived from, language (Vygotsky, 1976). Evidence of a relationship between teachers' language and the subsequent science conceptualizations of students already exists (Zeidler & Lederman, 1989). Specifically, if teacher discourse includes explicit communication of scientifically accurate concepts, for example, about models, students should be more likely to develop accurate understandings about models.

In a classroom learning environment, the language spoken by the teacher is, in part, influenced by the curriculum which guides instruction, and also provides a context through which to situate students in science learning. The curriculum used in this study articulates a project-based instructional stance and emphasizes investigation of authentic problems and participation in scientific practices, such as constructing and using models. Also included in the materials are explicit opportunities for discourse around the nature of science epistemic practices (e.g., modeling), something teachers rarely exhibit in their instruction (Windschitl et al., 2008a). For example, the curriculum includes explicit text that prompts teachers to discuss models in science, and ask students about their experience with models. A defensible hypothesis, therefore, is that the use of this curriculum will support teachers' more explicit language around model-based instruction. Challenges associated with enactment of project-based curricula have been well-documented (e.g., Blumenfeld et al., 1991), as have the challenges associated with model-based science instruction (e.g., Windschitl et al., 2008b). However, aside from outlining the components of scientific modeling and the characteristics of model-based tasks, the research is largely silent regarding the explicit language that has potential to engage students in authentic model-based inquiry. This study describes ways in which teachers utilize these innovative science curricular materials to situate students, through language, in model-based learning.

Methods

The primary data for this study include video-recordings of classroom instruction during enactment of a lesson focused on modeling in physical science. These data were gathered from the third year (2012-2013) of a five-year (2010-2015) study designed to examine the efficacy of a reform-oriented middle school science curriculum. Participants consisted of nine sixth-grade science teachers, selected because they exhibited explicit metamodeling instruction in their class. These teachers represented a range of teaching experience, education, and science backgrounds.

Given the social and situated framing of this analysis, and the focus on the construct of teacher language, we employed content analysis to analyze transcripts of teacher language during whole-class discussion. Constant comparative analysis (Glaser & Strauss, 1967), was used to identify language patterns across participants. Findings are presented by the themes that arose during explicit metamodeling instruction.

Results and Implications

Findings presented on this poster describe patterns in teacher language in science modeling instruction. Some illustrative findings are presented here, with more to be elucidated on the poster. We found evidence that these teachers' explicit metamodeling instruction both was derived from and supported by the curriculum. For example, the lesson text recommends that teachers tell their students, "Some models are simply smaller versions of the real object"; this guidance was taken up by five of the nine teachers in this analysis, who described models as "smaller versions" or "smaller scale" or "scaled down version" of the "real object." Additionally, the text prompts teachers to, "Ask the class if they have ever built a model car or train." Four of the nine teachers took up this instruction and asked, for example, "Has anybody ever built a toy plane or a train out of a model? You've made a model car, model train, model plane, right?" (excerpt 10).

This research has implications for curriculum developers and the writing of educative curriculum materials. While this analysis adds to other research evidence indicating that explicit metamodeling instruction tends to be rare in science classrooms, our findings also suggest that when provided access to appropriate curricular materials, teachers' enactment of explicit metamodeling instruction can be supported. Looking at the content of the curriculum and how the guidance for teachers was taken up during enactment, there is arguably a need for more support for metamodeling in order to help enrich teachers' interactions with students about the nature and purpose of models. Additionally, the metamodeling guidance needs to be more grounded in the context of the specific model used in the lesson. As reform-based science curricula aims to support a more robust understanding of science practices and engage students in science in more meaningful ways, it is important to understand the strengths and limitations of these curriculum materials in supporting teachers' efforts toward these ends.

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