

DOCUMENTING THE EMERGENCE OF “SPEAKING WITH MEANING” AS A SOCIOMATHEMATICAL NORM IN PROFESSIONAL LEARNING COMMUNITY DISCOURSE

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The purpose of this paper is to describe the sociomathematical norm of speaking with meaning. Speaking with meaning reflects the type of mathematical communication expected when a group of individuals are engaged in problem solving. We observed the emergence of this norm in professional learning communities comprised of mathematics and science teachers and use this data to illustrate its usefulness.

Introduction and Background

This paper describes the sociomathematical norm of *speaking with meaning* and its emergence in a Professional Learning Community (PLC). After studying the interaction patterns of four PLC's over one year, we observed that the quality of mathematical discourse was not very high. Based on these findings we introduced the term *speaking with meaning* as a way of making the nature of the discourse that we wanted to emerge among the members of the PLC more explicit.

The PLC's are defined as a collection of math and science teachers from the same school (ideally) with one teacher designated as a peer facilitator. The PLC design draws heavily from investigations of lesson study. The participants in the PLC's for this study were taking a graduate course that was focused on developing their understanding of the function concept. The purpose of the PLC's was to engage teachers in *meaningful discourse* about issues of learning and teaching mathematics content related to what they were learning in the course. For the purpose of this research we describe “meaningful discourse” as communication about knowing, learning and teaching that draws on coherent understanding of the content and the process of learning the content.

Each PLC has an assigned peer facilitator who manages the discourse for the PLC. The facilitator is initially trained and supported through weekly coaching sessions. Facilitators are also provided a PLC agenda that specifies points of discussion, questions and social norms for PLC interactions. Facilitators are encouraged to monitor PLC interactions so that the PLC members listen to and try to make sense of each other's solutions and offer justifications for their solutions. In this setting, the facilitator is trained to ask questions that promote *speaking with meaning*. They probe PLC members for clear articulation of their thinking and press PLC members to offer meaningful justifications for claims and statements. Within this environment, the PLC members' actions reveal what they believe are acceptable forms and patterns of communication.

Theoretical Perspective

Thompson, Philipp, and Thompson (1994) denote distinct differences between calculational and conceptual orientations. A calculational conception implies that a correct solution need only

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be justified using calculational sequences which are judged by criteria which may not be explicit to the whole audience. People who have a calculational conception have a tendency to give responses that consist primarily of numbers or numerical operations and procedures for arriving at an answer. In contrast, an individual who has a conceptual orientation is more concerned with the overall context within which a problem lies. He or she is also more focused on a broader system of ideas and ways of thinking and speaks about quantities and relationships when describing approaches or solutions. His or her explanations are typically grounded in the context and conceptions of the problem. The concept of *speaking with meaning* draws heavily upon the notion of a conceptual orientation. It is used to describe the type of “meaningful discourse” that is expected when individuals are involved in problem solving. *Speaking with meaning* implies that responses are conceptually based, conclusions are supported by a mathematical argument, and explanations are given using the quantities involved. Our viewing *speaking with meaning* as a norm reflects our observation that it has emerged as normative behavior within some PLC’s.

Sociomathematical norms refer to normative behaviors that are specific to mathematics, such as understanding what constitutes an acceptable mathematical solution, and emerge from what counts as acceptable mathematical behavior in the classroom (Yackel & Cobb, 1996). The sociomathematical norm of *speaking with meaning* is used to illustrate the type of mathematical behavior expected of the teachers as they participate in their PLC’s. In fostering the emergence of the sociomathematical norm for what constitutes a sufficient explanation or justification, the teachers established criteria for what it means to *speak with meaning*. These justifications need to be conceptual and embedded in the context of the problem. For example, explanations regarding rate would need to include language that describes how the amount of distance covered changes when considering changes in time. It is important to note that this lens for viewing our data did not emerge until after observing the discourse of the PLC’s. It was in watching videos of the PLC’s that we observed *speaking with meaning* emerging as normative behavior of the PLC.

Discussion and Implications

In order to establish PLC’s that engage in meaningful discourse with regards to teaching and learning mathematics, it is important to be aware of some interaction patterns that are more typical in low functioning PLC’s. During the first year of studying PLC interactions we observed teachers who spoke using partial phrases. Also, their solution explanations were often incoherent and did not connect to the context of the original problem. Based on these observations we created interventions aimed at improving the quality of discourse in the PLC’S. In the first class of the semester, the instructor managed a discussion with the class in which she negotiated productive patterns of communication for the class and PLC. From their negotiation emerged the term *speaking with meaning*. Teachers appeared to agree that they should attempt to speak meaningfully when discussing ideas and solutions.

Based on analysis of our data we found that it is difficult for inservice teachers to *speak with meaning*. It is important that the facilitator ensure that PLC members not only justify their own comments, but also probe each other when utterances are offered that are vague, incoherent or lacking meaning. We found that facilitators who were coached on specific actions to promote *speaking with meaning* were more effective in moving the PLC toward *speaking with meaning* as a norm that was spontaneously enacted in discourse within the PLC. The facilitators benefited by

hearing specific suggestions that were based on observed shortcomings in the facilitators' actions during his or her PLC.

This research has applications to both theory and practice. This study intends to add to the theoretical constructs sociomathematical norms. Specifically, *speaking with meaning* refers to the kind of normative behavior we would like to observe in a PLC of secondary mathematics and science teachers. Within that scope we use the phrase *speaking with meaning* to encompass the ways in which PLC members should communicate with one another regarding mathematics.

What counts as *speaking with meaning* is negotiated in a PLC and can differ from PLC to PLC.

The term *speaking with meaning* emerged from negotiations during the first day of class. The term carries with it the ability to operationalize what is a sufficient explanation; it also describes the attributes of meaningful mathematical communication. It has brought clarity to how to make a sufficient justification and is now an intervention that the teachers can use in their classrooms.

Speaking with meaning has the dual nature of being both a theoretical construct and an intervention. Researchers will be able to use this construct to gauge the quality of mathematical discourse in the teachers' classrooms. It was also used to help train facilitators so they could better manage the discourse of their PLCs. Further, *speaking with meaning* provides both teachers and researchers a lens with which they can judge the effectiveness of their attempts to enact and promote *speaking with meaning*.

By observing the emergence of *speaking with meaning* within a PLC we are becoming more aware of interventions and actions that may lead to *speaking with meaning* becoming normative within a PLC. This can help inform training of facilitators so that they can better engage the other members of their PLC. As these facilitators are peers of the other group members, they do not have extensive formal training necessary to bring about these normative behaviors. Therefore, appropriate training methods and interventions are very important in preparing the facilitators to manage the discourse within their PLC's. Becoming more aware of actions that produce *speaking with meaning* as a spontaneous behavior among all members of the PLC will help improve interventions designed to support *speaking with meaning* as a norm. Research reported in this manuscript was support by National Science Foundation grant number HER-0412537

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FROM PROFESSIONAL-DEVELOPMENT PARTICIPANT TO DOCTORAL CANDIDATE: THE JOURNEY OF ONE MIDDLE-SCHOOL MATHEMATICS TEACHER

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This case study reports on changes in the practices of one sixth-grade mathematics teacher over four years of professional development and implementation of new curriculum materials. Analysis of data points to an unexpectedly dramatic change in her knowledge, perspectives, and classroom practices. This study attempts to identify factors critical in producing such a dramatic and lasting impact.

The journey of Celia, from professional development participant to doctoral candidate, is both dramatic and inspiring. With 7 years of teaching experience, Celia lacked confidence and depth of knowledge of mathematics. She embarked on what turned out to be a four-year odyssey of professional development activities that resulted in lasting changes in her knowledge, perspectives, and practices. The question arises, “What factors were critical in producing such a dramatic and lasting impact on this teacher?” This paper will attempt to answer this question.

Background

Analyzing and describing the impact of professional development activities has the potential to significantly improve the design of such activities (Becker & Pence, 2003; Farmer, Gerretson, & Lassak, 2003; Murata & Takahashi, 2002). However, a report by RAND (2003) suggests that professional development practices have not been studied extensively and there remains a great need for well-developed descriptions of successful professional development practices

In this study, we address three questions. First, what changes in Celia’s classroom practices, perspectives, and knowledge emerged and remained over the four-year period? Second, what professional development activities were critical to effecting lasting change on her knowledge, perspectives, and practices? Third, what factors external to the professional development activities appear to have impacted their effectiveness?

Perspectives and Framework

Our perspectives on the nature of mathematics, learning, and teaching guide our design of professional development activities. We believe that understanding of mathematics involves (1) the ability to solve problems, (2) the ability to connect mathematical ideas to one another and to real-life contexts, and (3) the ability to communicate mathematics to peers. We believe that learning of mathematics is best achieved by active engagement in activities that call on and develop the abilities involved in understanding of mathematics. Thus, the teaching of mathematics should be designed to provide such opportunities to students and professional development should help teachers develop, implement, reflect on, and revise such learning opportunities.