

Appreciating the Complexity of Teaching and Learning in School: A Commentary on Cobb; Forman and Ansell; McClain; Saxe; Schliemann; and Sfard

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What is most striking about these articles is their similarity rather than their differences. All of the authors recognize that in school, students learn by interacting with cultural artifacts, teachers, and peers. All aim to conceptualize the mechanisms whereby such interactions might support the acquisition of new knowledge and skill. Each article brings a different lens to the classroom learning environment, but every article purports to hold all of these kinds of interactions in view at once rather than screening out some and focusing on others.

In all learning encounters, students act in a relationship with that which is to be learned; this action takes the form of what Sfard called “school discourse.” Sfard defines the purpose of activity in this relationship as improving communication with self and others in such a way as to be able to use cultural artifacts to solve problems. I have taken to calling this kind of activity “studying.”¹ In relation to the kind of learning practices that occurred in the stats project lessons, I would use the term *studying* to include activities like inquiring, discussing, thinking, reading carefully, and examining closely. Teaching then would be defined as the practice of structuring the activities of studying in relation to particular content and particu-

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¹Unfortunately, the word *studying* has taken on negative connotations when it is connected with schoolwork; we often take it to mean cramming, memorizing, keeping one’s nose in the book. I would like to revive a more general and positive interpretation of the term and use it to mean any practice in which students engage in school to learn. What I am calling studying here resembles what Bereiter and Scardamalia (1989) called “intentional learning.”

lar students.² If teaching is successful, students have opportunities to study. They can be active participants in school discourse and use it to learn.

From this perspective, we can see the articles in this issue as being about the mechanisms whereby it becomes possible for students to study productively in school. Teacher, peers, and cultural artifacts mediate students' interactions with that which is to be studied. We see in the articles how these elements of the learning environment can both constrain and support learning, depending on how they are used. As Schliemann reminds us, tools do not directly determine students' ways of reasoning, and inscriptions are always open to multiple interpretations. Forman and Ansell draw on the image of "orchestrating" to describe the work of the teacher in bringing these multiple interpretations to bear productively on the learning process. They assert, for example, that inscriptions can be used to create argumentative positions (to do what Cobb calls "backing"), but students do not always use them in this way. Forman and Ansell identify several mechanisms a teacher can use to encourage students to use them in this way. Unpacking the teaching action of "revoicing" in the data from the two lessons, they find pedagogical practices like repeating, rephrasing, summarizing, elaborating, translating, animating, and legitimating (O'Connor & Michaels, 1996). Drawing on the other articles, we see that the teacher and the students who teach one another used these and other mechanisms to provide opportunities for members of the class to study mathematics.

In the stats project classroom, one reason that students interact with the teacher, other students, and cultural artifacts is to study some mathematics.³ They study "relative frequencies and proportionality" (Schliemann) and "the overarching statistical idea of distribution" (Cobb). But it is not only mathematical ideas that are studied. Simultaneously, students are learning how to study this mathematics with a particular set of peers, a particular teacher, and a particular set of tools. They are learning a set of norms for interacting with one another and with cultural artifacts as they engage in mathematical activity. At first, we are told, students see the data points as individual entities. They talk about them and reason about them in that way. Later, they communicate about the same data points as collections, as new entities with their own properties, properties that enable decision making about buying batteries, and choosing medical treatments. The discourse changes from calculational to conceptual. How does this happen?

In asserting that "the discourse" is the unit of analysis, Cobb draws our attention to the continuity of classroom interaction as one factor that makes it possible for students to study the norms that support their studies of the target ideas. Although the

²See Lampert (2001) for a further explication of the kinds of problems a teacher must address to support students' productive studying while they work on problems in school.

³They interacted for other reasons as well, and this is hinted at in some of the articles, but it is not a focus of the analysis.

authors of the articles in this issue had only two lessons to examine, one from the 9th of 37 lessons, and one from the 32nd lesson, these students and this teacher spent 12 weeks working with the artifacts and ideas under consideration. As portrayed in these articles, the mechanisms that enable productive practices of teaching and learning require a time frame in which sustained interaction can occur. When we ask, as Forman and Ansell did, “Do this teacher and these tools support students’ ability to reason about data while developing statistical understandings?” we need to recognize that an affirmative answer would need to be qualified with the caveat, “over time.”⁴ Several of the articles explain why time is a necessary but not sufficient condition for the kind of teaching and learning the designers wish to support. They demonstrate that a key element in forming a productive discourse in these classrooms is that the students and the teacher get to know one another and form social relationships over time that support the students’ capacities to study the mathematics with which the project is concerned.

We hear from the teacher, Kay McClain, something about how those relationships are formed and sustained over the 12 weeks of lessons and also about why they are necessary for teaching and learning. She required sustained interaction to learn about her students and about the mathematics they needed to learn. To get students to reveal what she needed to know to teach them, McClain first had to enable interactions in which her students’ skills and knowledge would be visible. Having done so, she was able to learn both about her students and about the mathematics she was trying to teach. She courageously admits that getting to know students and mathematics through interaction in the classroom environment is a daunting task. She observes that “making reasoned decisions about how to proceed,” is to understand not only “students’ solutions” but also “the mathematical purpose of each classroom task.” Balancing these multiple agendas makes it difficult for her to communicate effectively with students during discussions, and this communication, analysts of her teaching tell us, is the key to creating an environment in which students can study what it is they are to learn.

From a developmental perspective, Saxe pulls apart the multiple learning agendas that McClain is trying to manage, showing us at the end of his article (Figure 5 of Saxe, this issue) that the microgenesis of each student’s understanding overlap with the sociogenesis of the goals which that student holds in common with and accomplishes with another student, and that this individual and overlapping understanding develops ontogenetically from one point in time to another. What Saxe portrays is the complex interplay in figuring out the development of understanding for two students interacting between two points in time. As teacher and instructional designer, what McClain is challenged to learn

⁴Another caveat, added by Forman and Ansell, is that teachers, peers, and tools support this development unevenly across time and across individual students. Unfortunately, I do not have the space here to take up this issue, but it is a central problem in this kind of teaching.

about and use in her practice is many times more complex. She has many more than two students. Their sociogenetic development occurs not only in several and varying pairs but also in the continually shifting alliances and enmities that define social subgroups within the class. And the time frames of the developments in their understandings that she has to keep in mind ranges from moment-to-moment to lesson-to-lesson to the whole 12-week period over which the project unfolds. She continually has to do the work of instructional design interactively with students, even though she is equipped with a set of sophisticated tools, a well-prepared set of tasks, and clearly defined goals for her students' mathematical learning. She and her students have to design and enact the practices that make it possible for the instructional goals of her colleagues in the research team to be realized.

In terms of our understanding the kind of teaching and learning of mathematics that went on in the stats project, this set of articles marks a major step forward. It goes far beyond the vague notions that teachers need to "help" students or "encourage" them rather than to tell them things and to make them practice. It makes more vivid why this kind of teaching and learning must evolve over time, because these practices are embedded in relationships and governed by social norms which themselves must be studied and learned by participants. The "normative purposes," "normative standards of argumentation," and "normative ways of reasoning with tools and inscriptions" whose development Cobb describes are not present when a group of students and a teacher begin to work together, and if they are to support mathematical practices as well as school discourse, their development must be deliberately designed and continuously managed in the interaction of tools and persons. In these articles, taken together, the complexity of this management work is well represented.

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