Preface to Part XIII

Studying Goals and Beliefs in the Context of Complexity

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Teaching mathematics in a classroom of students is an activity that to some observers may seem fairly straightforward—the teacher leads a planned activity whose goal is to achieve one or more mathematical learning objectives; the students engage in the activity, and (to varying degrees) acquire the desired skills and develop some mathematical understanding. Such a characterization of teaching suggests that the main problem of mathematics education research is to identify the characteristics of classroom activities that maximize student learning.

However, successive decades of research have uncovered layer upon layer of complexity in the classroom teaching process. Teachers' and children's cognitions and orientations are complicated and vary widely. Methods that some teachers employ successfully are extremely difficult for others to use, while activities that are effective with some children are ineffective with others. Social and cultural factors exert profound influences—in the United States and elsewhere large populations of students, including economically disadvantaged children and racial minorities, remain "left behind" in mathematics. Conceptions of what mathematics is, and what it means to learn, to teach, and to do mathematics, also vary widely; so that controversies over "traditional" vs. "reform" mathematics education continue mostly unresolved. Evidently, if we wish to improve instruction systematically, it is important that we not limit ourselves to a simplified view, but that we *elucidate* and *address* the complexity of classroom teaching.

Let us mention just a few aspects of this complexity. Students, teachers, educational administrators, and parents have individual *goals* (sometimes shared, sometimes not)—and those taking problem solving approaches to mathematics education have highlighted the importance of goals, as understood by problem solvers, in mathematical activity (e.g. Schoenfeld 1985, 1994). Each person involved comes into the classroom process with prior *knowledge* and expectations for using that knowledge—and those taking cognitive science approaches to mathematics education have sought to elucidate the complex representation of knowledge (e.g. Davis

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1984; Goldin and Janvier 1998; Hitt 2002). The influential book edited by Leder et al. (2002) highlighted another aspect of this complexity—the dimension of *beliefs*, including mathematics teachers' beliefs, students' beliefs, beliefs about the self, and some rather general beliefs relating to mathematics and mathematics learning.

In recent years our group at Rutgers University—with the goal of studying student engagement in conceptually challenging mathematics—studied several urban American classrooms through four "lenses" simultaneously: the flow of mathematical ideas (mathematical/cognitive); occurrences of strong feeling or emotion (affective); social interactions among students (social psychological); and significant teacher interventions (Alston et al. 2007). Each of these contributes its own, complexly-woven strand to a still-more-complex tapestry. And there are many more essential aspects—e.g., the sociocultural dimension (e.g. Seeger et al. 1998; Anderson 1999), including the relation between "street culture" and classroom culture (in general, and in relation to mathematics and its use), the role of societal expectations, and so forth.

One way to take account of the social environment and its influences is to consider how aspects of that environment are represented or encoded in the individual teacher, and to ask whether this can account for key events that occur during mathematics teaching. The article that follows by Törner, Rolka, Rösken, and Sriraman undertakes to look at this problem in the context of one mathematics lesson, and one key event during that lesson—the teacher's decision to turn off the computer after 20 minutes, in what was originally intended to be a computer-based introduction to linear functions.

The authors conclude that an approach based on Schoenfeld's work, taking into consideration the teacher's knowledge, goals, and beliefs ("KGB"), can in fact account adequately for the turn of events that occurred. In the process, they provide us with a richly-textured, detailed characterization of goals and beliefs, including a discussion of how goal and belief "bundles" are structured. Thus we obtain an interesting "window" into the complexity of interactions in a mathematics classroom, and an indication of the kinds of issues needing attention as we strive to improve mathematics teaching and learning.

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