Preface

During the summer of 1990, while taking my holidays to teach a university course of physics for elementary teachers, I also tutored one of the tenth-grade students at my school in physics, chemistry, and mathematics. In return for working with him for free, I had requested permission to audiotape our sessions; I wanted to use the transcripts as data sources for a chapter that I had been invited to write. It so happened that I discovered and read Jean Lave's *Cognition in Practice* that very summer, which inspired me to read other books on mathematics in everyday situations. Two years later, while conducting a study with my teacher colleague G. Michael Bowen on eighth-grade students' learning during an open-inquiry ecology unit, I discovered these students' tremendous data analysis skills that appeared to be a function of the deep familiarity with the objects and events that they had studied and mathematized earlier in the unit. I reported my findings in two articles, 'Mathematization of experience in a grade 8 open-inquiry environment: An introduction to the representational practices of science' and 'Where is the context in contextual word problems?: Mathematical practices and products in Grade 8 students' answers to story problems'.[1] Beginning with that study, I developed a research agenda that focused on mathematical knowing in science and science-related professions.

During the early 1990s, I was also interested in the notion of *authentic practice* as a metaphor for planning school science curriculum. To achieve the goal of a more 'authentic' curriculum, I wanted to find out what scientists actually did at various moments of their work and how their actions and experiences related to their scientific and mathematical competencies. I was particularly interested in the representations scientists used in their journals and that somehow were the outcomes of complex processes in their workplace. Because of the prevalence of graphs in science, I wanted to find out how scientists interpreted them so that I could develop a normative framework for the appropriation of graph-related competencies in my school-related work. This initially led me to a comparative investigation of graphs and other mathematical representations in scientific journals and high school biology textbooks and subsequently to a study of graph interpretations by scientists.[2]

During the initial graph interpretation sessions, I was quite stunned noting that scientists were not at all the experts that the science education and expert-novice literatures portrayed them to be. I found scientists to make errors similar in structure and kind to those children had been reported to make. But, because of the experience and background that these scientists have had, I could not plausibly seek recourse to the same deficit explanations (variously labeled 'misconceptions', 'mental deficits', or 'misunderstandings') that had been used with students. I therefore decided to study the phenomenon more exhaustively by seeking situations where I could follow scientists or technicians in their work to understand their work-related graphing expertise and how it related to the problems that scientists faced when asked to interpret introductory-level graphs in their own discipline. This book is the result of several years of studying the development and use of graphs by scientists and of the interview study in which scientists responded to several graph interpretation tasks.

A book like this does not flow from an author's mind but is the outcome of an agency-structure dialectic. Structure includes the social relations that an author maintains with colleagues, research assistants, research participants, and granting agencies. Without such relations, I could not possibly be the researcher and author that I am. I therefore want to thank all those who, in direct and indirect ways, allowed me to write this book (my agency). First of all, I am grateful to the scientists who took time out of their busy schedules to comply with my interview request and to those who allowed me (or my graduate students in some cases) to spend time in their laboratory or field research sites to observe them in their activities and, sometimes, to participate as an apprentice in their research in ways that fit the need of the ongoing work.

I am also grateful to those individuals who assisted me in collecting the data by interviewing scientists, videotaping the encounters, or transcribing the video- and audiotapes. These individuals include G. Michael Bowen, who completed his doctoral dissertation under my supervision during the time that these studies were conducted, and my wife Sylvie Boutonné, who contributed as a research assistant, videotaping sessions, and transcribing the tapes. In the same breath, I acknowledge the Social Sciences and Humanities Research Council of Canada, which supported the work presented here through two regular grants and one major collaborative research initiative grant. Michelle K. McGinn was an early companion in my research on graphing. In our discussions, which also related to her own MA work on mathematics in the kitchen, I developed my understanding

of the situated nature of mathematics in science. Domenico Masciotra and Daniel Lawless, too, were valuable discussion partners while I attempted to think about developmental aspects in the relationship between individuals and graphs. In many discussions with Kenneth Tobin, I have had opportunities for articulating and elaborating issues surrounding activity theory and its application to concrete settings. Tracy Noble, Julian Williams, Jim Kaput, Celia Hoyles, and Richard Noss have been gracious listeners and respondents to various aspects of this work.

My ideas and understanding also developed as I attempted to articulate them in articles submitted to a variety of research journals. I attempted to communicate how scientists used graphs, how they responded to my graphing tasks, and how they arrived at and interpreted graphs that issued from their own engagement in research. But I did not always arrive at making myself clear. The anonymous reviewers of various journals, representing my community of practice, have pushed me to articulate my ideas more clearly and therefore deserve special thanks. The resulting publications in *Journal for Research in Mathematics Education*, *Cognition and Instruction*, *Journal of Curriculum Studies*, *Social Studies of Science* (Chapter 7), *International Journal for Computers in Mathematical Learning*, *International Journal of Learning Technologies*, and *Science, Technology, and Human Values* were important starting points for the ideas presented here.

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