A VOLUME IN **SCIENCE & ENGINEERING EDUCATION SOURCES**

SUCCESSFUL SCIENCE AND ENGINEERING TEACHING IN COLLEGES AND UNIVERSITIES

2ND EDITION

CALVIN S. KALMAN

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Science & Engineering Education Sources
Calvin S. Kalman, *Series Editor*

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Concordia University

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This volume is dedicated to my wife Marilyn, my children Ben and Sam, grandchildren Josh, Lily, and Max, and as I have indicated in the acknowledgment section, this work would never have come to fruition if it were not for the inspiration and ideas from my late wife Judy Kalman (February 23, 1946–June 29, 2006) in addition to her unflagging support and encouragement. She was a truly great teacher and a model for my own teaching.

—C.S.K.

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About the Author

Calvin S. Kalman is a tenured full professor in the Department of Physics and principal of Science College at Concordia University. He is also an adjunct professor in the Department of Educational and Counseling Psychology at McGill University. He has held many positions at Concordia including chair of the Department Physics. He has been the chair of the Division of Physics Education of the Canadian Association of Physicists.

He was awarded the Canadian Association of Physicists Medal for Excellence in Teaching, the Concordia University Council on Student Life Teaching Award, and the Arts and Science Dean's Lifetime Achievement Award for Teaching Excellence. He is a member of the Provost's Circle of Distinction at Concordia University, and received a Teaching and Creativity Award from the Society for Teaching and Learning in Higher Education.

Kalman authored *Successful Science and Engineering Teaching: Theoretical and Learning Perspectives* and *How Did We All Begin, Where Is God in All That?*

He has been chair of the international series of conferences on hyperons, charm, and beauty hadrons (Montreal 1997, Genoa 1998, Valencia 2000, Vancouver 2002, Chicago 2004, Lancaster, England 2006, North Carolina 2008). He has also been editor-in-chief for the proceedings of these conferences. He co-chaired and co-edited the 26th annual Montreal-Rochester-Syracuse-Toronto (MRST) conference on high energy physics,

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and coauthored the book: *Preons: Models of Leptons, Quarks and Gauge Bosons as Composite Particles.*

Kalman was science editor and senior executive editor of *Academic Exchange Quarterly* and is on the editorial board of *Science & Education.*

Altogether he has been an author of 75 published papers related to high energy physics and 58 papers on science educational research. He has often been invited to give papers or workshops on educational research. For example, he gave the keynote address at the annual spring teaching forum, Teaching the Future: Innovation in the College Classroom at Yale University and presented the keynote address to the Physics & Engineering Physics Division annual meeting of the American Society for Electrical Engineers. He has served as commissioner for elementary schools and also as commissioner for high schools of the Protestant School Board of Greater Montreal.

Acknowledgments

First, I credit my late wife Judy Kalman (February 23, 1946–June 29, 2006), who had many successes in teaching writing at Concordia University and Dawson College, with inspiring much of my effort to bring writing into the science classroom. She also convinced me to set aside my initial skepticism of writing methods such as journaling to attend an intensive two-day workshop at the University of Vermont that impressed me enough to try some new techniques myself (the course dossier). She and Marjorie McKinnon were instrumental in convincing me to use collaborative groups in my teaching. At the time, Marjorie was associate director of the Concordia University center for faculty development. My first efforts in innovative teaching based upon computer assisted instruction would never have come to fruition without the help of Ron Smith and David Kaufman. Craig Nelson, whom I have never met, inspired my idea to follow conceptual conflict collaborative group exercises with a writing activity. Without the support and many discussions provided by Mark Aulls, I would never have come to my understanding of how reflective writing worked. The first edition of this book owes much to Carolyn Dumore, managing editor at Anker Publishing Company. She carefully went over every word and provided helpful suggestions for revisions. I would like to thank Teresa Larkin for sharing the guidelines and call for papers along with brochures to illustrate my discussion of her end of semester conference. Some parts of this book have

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appeared in articles I wrote for *Physical Review Physics Education Research, The Canadian Journal for the Scholarship of Teaching and Learning, Physics in Canada, Canadian Journal of Physics, American Journal of Physics, Science & Education,* and *Academic Exchange Quarterly.* I wish to thank Thomson Learning and Toby Fulwiler for granting me permission to reproduce and/or paraphrase some material in this book.

Foreword to the Second Edition

Many advances in research in science education have occurred since the appearance of the first edition of this book over 10 years ago. For example, much more is now understood about how Reflective Writing benefits students. Most important on this point is that much better instructions are available for students on how to use reflective writing. A rubric has been constructed that simplifies the marking of Reflective Writing. It also has been rightly pointed out that there was no discussion of peer instruction in the first edition. Since then research has been done comparing peer instruction with the conceptual conflict collaborative group activity that was described in the first edition. There is a description of an activity called labatorial that combines tutorials with labs. This edition now includes a discussion about the long-standing debate in the science education community between those who believe that students come into the classroom with a theory about the subject, which is different from that described by the teacher and found in their textbooks; and those who feel that a student's knowledge consists of isolated structures called *phenomenological primitives* (p-prims). The former was the accepted paradigm on student conceptions in science in the 1970s through the 1990s. Discussion is included here of new information on how combining Reflective Writing with one or more interactive interventions can produce statistically significant changes in how students learn.

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Author Note

This book is intentionally informal. In writing it, I have viewed it as a discussion of our mutual interest in helping students learn. I hope that you will continue the conversation by letting me know what works for you and ways that you have changed the material that I present in ways that work better in your courses.

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