Foreword

The effective communication of science through language, including reading, writing, listening, speaking, and visual representation, is an essential part of scientific learning, understanding, and practice. Language is the medium by which scientific reasoning occurs, whether be it formal language or symbolic representations of scientific phenomena. Language permits one to reason critically and analogically, to be creative, to formulate explanations, to integrate knowledge and to transfer and apply knowledge in a sound manner to the solving of problems.

Language also allows one to perform the process of science, including constructing hypotheses, formulating research questions, selecting appropriate methods, analyzing and reasoning deductively and inductively about data, identifying limitations and exceptions, making generalizations, and relating new finding to existing knowledge. Besides verbal language, scientists rely heavily on the use of symbolic language, including scientific and mathematical symbols and representations (e.g. pictures, images, diagrams, graphs, tables, charts, animations, models), to illustrate and interpret scientific phenomena and results. As does verbal language, representations all have limitations that can make it difficult for students to understand and communicate science.

Thus scientific language and literacy is indispensable to scientific thinking and reasoning and needs to be developed in parallel with the development of scientific knowledge and understanding. But whereas most instructors expect higher-level scientific reasoning and expression from their students, few have the tools and techniques necessary for promoting and supporting students’ use of scientific language. This book in emphasizing this problem has as its major focus how language support might be introduced and sustained in science education.

In addressing this issue the authors focus on a wide range of practical approaches, strategies, and solutions imported from language studies that could be readily implemented by practitioners to improve the scientific literacy of students across multiple scientific disciplines, particularly those from diverse language and educational backgrounds. For example, Zhang (Chapter 1) advocates the use of active learning strategies that are widely used in language learning, to enhance deep conceptual understanding in science by students from diverse backgrounds. Bridgeman (Chapter 2) in contrast reports on the use of online tutorials to enhance students’ symbolic language used in chemistry. Yates and Gardiner (Chapter 3) on the other hand report on activities that help avoid the problems of limited access to technology at some institutions, by introducing activities that develop verbal and symbolic language through the use of mobile-phone based technologies, word-matching exercises, crossword and Sudoku puzzles, and songs.

Lidbury (Chapter 4) advocates the use of various paper-based tutorials and online language exercises and strategies designed to promote language competence, motivation, and scientific reasoning in genetics and molecular biology with a specific focus on the drawing and symbolic representation of genetic
concepts. Zhang and Lidbury (Chapter 5) report on the use concept inventories to diagnose genetics learning while Mate and Rodger (Chapter 6) report on various lecture and tutorial based interactive language focused interventions in the context of human physiology and biology. Schulte (Chapter 7) focuses on physics literacy, Richardson (Chapter 8) on the use of clickers in enhancing statistical literacy, and finally Zhang (Chapter 9) summarizes the findings in this book by proposing a model for addressing language difficulties in science education, based on strategies transferred from the language arts.

Over the years there has been a dearth of projects involving cross-disciplinary teams addressing the crucial issue of the interaction between language and conceptual understanding and learning in science. This book will go a long way towards filling this gap in our knowledge and at the very least it will raise awareness among science educators of the different types of verbal and symbolic language used to communicate science, the demands they make on the students and the difficulties they could encounter that might necessitate remediation.

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Trevor Anderson is a member of the IUBMB Educational Committee and the editorial board of “Biochemistry & Molecular Biology Education”. In 2007 he was a recipient of the Monash University, Biomedical Sciences “Scholar in Residence in Education” award. He has extensive experience in science education research focusing mainly on conceptual understanding, visual literacy, scientific reasoning, and curriculum change. He is particularly interested in symbolic language and improving the design and use of representations for the development of conceptual knowledge and visualization literacy. He has published widely and presented numerous keynote talks and faculty development workshops. He is the author of the Bridging-the-Gap series in “Biochemistry and Molecular Biology Education” that promotes the application of educational research to teaching practice. Central to his faculty development activities has been the design of the conceptual and reasoning difficulties (CARD) e-resource (http://www.card.unp.ac.za) aimed at developing teacher competence at tertiary and secondary levels.