# Book Review

## *Doing Science: Design, Analysis, and Communication of Scientific Research*

by I. Valiela (Oxford University Press, 2001) 294 pp. , ISBN 0-1950-7962-0; $75 00 (hardcover)

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The author of this book has been doing research and training scientific workers for perhaps the past forty years, most recently while at Boston University and the Marine Biological Laboratory at Woods Hole, MA. What he has tried to do in this book is to convey how one becomes a practicing scientist. Since he is not a chemist but rather a biologist, his use of the literature is very biologically oriented, which at times means that, as chemists, we cannot immediately relate to some of his examples.

There are a number of books that have, with varying degrees of success, attempted to teach the novice or lay person how to perform good science. I am not at all convinced that this particular text is any better than others such as Wilson's *An Introduction to Scientific Research* or Medawar's *Advice to a Young Scientist* or Noltingk's *The Art of Research*.

The book starts out (Chapter 1) with a discussion of the various classical sources of scientific information. Unfortunately, there is not much mention of how to use computers or the internet for scientific research. Chapter 2 discusses the collection of scientific data (what sort of data are needed to answer specific questions) and then gets into some statistical treatment of data as a way of introduction to more detailed statistics in Chapter 3, a 30- page chapter covering the basics of statistical analysis, including topics such as analysis of variance, regression, correlation, frequencies, confidence limits, error propagation, transformation of data, and related items. The material is covered very nicely, very clearly, and very cleverly, but one wonders if almost two full chapters are warranted in a generalized book on Doing Science. Even so, there is insufficient discussion of repeatability, replication, reproducibility, validation of methods and results, testing of results/data, and so forth.

Chapter 4 covers the most important part of Doing Science: the principles of research design. This is an incredibly important part of Doing Science, because it takes the original question to be answered and attempts to set up the specific research experiments that will generate the data needed to answer the original hypothesis. Valiela summarizes some of the desirable properties of research design: laying out of the research experiments, what results are expected from these experiments, what those results would teach us in answering our original questions/ hypotheses, and then how to actually design sensible experiments. This is the "how" section of Doing Science — how are we going to answer the original questions or problems that we think are worth addressing? Even if we have chosen the right scientific problems to address at the outset, if we don't know what experiments to set up or how to design those experiments, then we will never perform successful science. We might Do Science, but we will never do good or correct science without first knowing how to set up the right experiments. The matter of how we know which experiments to establish in order to answer specific questions is not really addressed, but it should have been. It is in the choosing of individual experiments, controls, blanks, and so forth that we generate the critical data that we need to answer the original questions or hypotheses which started us off on the path of Doing Science. I liked this chapter very much. It was very well done, but I would have liked to see more of a connection between the questions needing answers, the scientific literature, and the design of specific experiments. There is little discussion of how we come up with our first set of experiments. Did we use the existing literature, did we just conjure up specific experiments without using previous literature, did we use textbooks? Scientific productivity and efficiency are hardly covered, but rather assumed, when really these often need to be instilled and inculcated in students and, sometimes, even in more mature colleagues. We need to nurture our students and colleagues not only on how to do good science, but how to do it efficiently, effectively, and with the maximum productivity for the money, time, and effort spent.

Chapters 5-7 deal with the dissemination or communication of scientific information, the writing of papers, reviews, abstracts, proposals, technical reports, progress reports, and the like. What is not discussed is how to choose a specific journal or meeting in which to present one's data for the first time. Journals provide specific guidelines for the style and format of scientific papers; these differ from journal to journal, but Chapter 6 takes a one-size-fits-all approach to organizing and writing a scientific paper. It also does not really differentiate between the different types of papers: preliminary communication, full, original research paper, review paper, rebuttal paper, mini-review paper, and others. Chapter 7 deals with other ways to communicate science, poster presentations, the formal scientific lecture/talk, or the proposal for funding. Chapters 8-10 deal with presenting data via tables, figures, graphs, histograms, bar graphs, pie diagrams, and so forth.

Chapters 5-10, roughly 50% of the entire book, were thus devoted to communication of scientific information via writings or lectures/talks. Is this a book on Doing Science or one on presenting results and data? As you may imagine, my original enthusiasm for the book was tempered as I approached the ending, Chapter 11. This last chapter is not at all about Doing Science, but rather a discussion about how science is perceived by the public today and how it might be improved in the future. In general, this was an interesting chapter, but it did not have anything to do with the practical aspects of Doing Science.

I found the book somewhat of a difficult read, very thought-provoking, at times stimulating and insightful, but never dull. I felt, perhaps above all, that it was imbalanced and did not hit some of the most important points. Topics that might have been of interest could have been a discussion of research group management, instruction of graduate students and postdoctoral fellows in research activities, group meetings, presenting group results at scientific meetings, and so forth. It might also have been interest- ing for the reader to learn the actual process of how a paper gets published: the various steps, from start to finish, even to describing proofreading of galleys, and what to do with reprints. Because Doing Science always requires getting funding, I felt that this topic was understated and relegated to a secondary status of importance. In reality, of course, it is perhaps the single most important topic, for without funding it is impossible to Do Science for very long. Even within industry, Doing Science really requires getting funded. The proposal is so terribly important, which does not really come across well enough in this book, that again there are entire books devoted just to writing of proposals. Though the submission of proposals is discussed with regard to governmental vs. private/industrial funding sources, a lot more could have been included about contacting grant officers, project officers, contract officers and so forth, to plan out the proposal, prior to actually writing it.

Would I recommend this book for the average chemist's bookshelf? Probably not. I am not at all sure it is aimed at a chemistry audience, and it is also not clear if it is aimed at graduate students, postdoctoral fellows, technicians, professors, industrial group leaders, directors of research, or what group of scientists. While it does address most of the major issues in Doing Science, it has missed some others.