

Preface

A preface is the place where you expect to have some questions answered: What is this book about? Who is the intended audience? What value might I expect to get out of it?

Although this book is associated with The Physics Suite and is distributed as an instructor's guide to using The Physics Suite, it really tries to be more than just a how to book for a particular set of materials. This book is about learning to be a more effective teacher.

The intended audience is any physics teacher who is interested in learning about recent developments in physics education. In contrast to some other teachers' guides, it is not a review of specific topics in physics with hints for how to teach them and lists of what common student difficulties are. Rather, it is a handbook with a variety of tools for improving both teaching and learning of physics — from new kinds of homework and exam problems, to surveys for figuring out what has happened in your class, to tools for taking and analyzing data using computers and video.

Over the past two decades, a community has grown up in the scholarship of teaching and learning, bridging physics and education. The people in this community, which I refer to as *Physics Education Research* (PER), have tried to understand why so many students have so much difficulty understanding physics, and they have tried to develop learning environments to help those students. The result has been a large body of knowledge and a growing repertoire of curricula that are demonstrably more effective than our traditional approaches.

The Physics Suite integrates materials from an active group of PER developers. All the parts of The Physics Suite are based on education research and share a specific underlying philosophy. This book, while providing an introduction to the materials of the Physics Suite, more importantly, provides an introduction to the educational philosophy and knowledge base that form the foundation underlying the Suite. Because this educational philosophy and knowledge base rest on well-documented scholarship, the foundation is broadly applicable. This foundation and this book can help you to teach better even if you do not adopt a single item from The Physics Suite.

Because the character of the book arises in a very personal way from my own experiences, let me introduce myself briefly. I was trained as a theoretical nuclear physicist and began my teaching career at the University

of Maryland in 1970. I have been on the Maryland faculty ever since, teaching and doing research. From the first I had a strong interest in teaching. From the first, I cheerfully ignored my colleagues advice to put a minimal effort into my teaching duties, since they would play little role in helping me get tenure.

In the 1980s I worked on trying to get the newly-invented personal computer into my classes. But as the decade went on, I became increasingly aware of two important facts: First, that my students were having trouble learning physics — both with and without the computer — and that their problems were more difficult to resolve than I had expected. Second, that there was a community that knew this and was studying it as a research effort. In 1991, I stopped doing nuclear physics and switched my research activity to PER.

This history determines the structure of the book. Some of what I have learned in 30 years of teaching has been from the research literature in PER and from my own work as an active physics education researcher. But a lot has been from listening to and working with the students in my physics classes over all those years. As a result, some of what helps my teaching is well documented through published research, but some is not.

Therefore, I have chosen to present this book as neither a research monograph nor as a standard didactic “how-to” teaching guide. Rather, I have decided to make it a “teacher-to-teacher” discussion in which I present what I have learned in three ways: as research results with data and citations where they are available, as illustrative anecdotal examples from my own experience, and as general principles, guidelines, and heuristics that I have found helpful.

The anecdotal examples do not always follow the events exactly. Sometimes multiple stories have been combined and details omitted for clarity. Although these stories are based on real events, they should be interpreted as fables with morals rather than as records of real events.

I have tried to limit my general principles to ones that can be supported in three ways: by observations of real student behavior in real classrooms (usually by educational researchers), by controlled experimental studies on how people think (usually by cognitive scientists), and by physiological plausibility (consistency with what is known in neuroscience). Heuristics (such as “Redish's Teaching Commandments”) are less well-documented and based on my own experience and what I have learned from other physics teachers.

Throughout my career as a research physicist, my work had a strongly theoretical bias. I have always been interested in trying to understand how to think about and organize our knowledge of the real world. For trying to understand the system of students trying to learn physics, the appropriate theory to help us parse what we see into something sensible is cognitive science. As a result, this book has a strong cognitive flavor. Though I do not want to write a textbook in cognitive science, I have tried to extract and make plausible for physicists what is relevant and known in this area. For those who want more documentation or to understand better the strengths and limitations of what is known, I refer you to the references cited in the text.

This book has four parts:

- An introduction discussing the structure of The Physics Suite and the motivation for educational reform in introductory physics. (chapter 1)
- A discussion of what is known about how people think that is relevant for physics teaching and learning. (chapters 2 and 3)
- Two chapters about assessing individual students learning and evaluating the success of instruction for a class. (chapters 4 and 5)
- A survey of various methods for creating learning environments that can help to improve student learning, including both tips from my own classroom experience and descriptions of the PER-based curricular materials and methods belonging to The Physics Suite and some other methods that work well with it. (chapters 6-10)

Finally, the book comes with a *Resource CD*. This contains

- our Action Research Kit — a collection of concept and attitude surveys
- resources for exploring computer-assisted data acquisition and analysis and video data handling
- resources for getting information about PER.

In the Appendix to this volume, I list the material available on the disk. The disk is attached inside the back cover. If it is missing in your copy, contact John Wiley & Sons to get one.

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start in learning how to do PER and a view of what a PER group inside a physics department looked like.

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