RESEARCH ARTICLE | NOVEMBER 01 1989

A Means to an End

Denis Donnelly

Comput. Phys. 3, 112 (1989)
https://doi.org/10.1063/1.4822875

ESSAY

A Means To An End

BY DENIS DONNELLY

We know more than we can tell. Consequently, there are occasions, perhaps frequent ones, when we cannot impart the knowledge that we have and do not teach what we intend. A noted naturalist, at one point in his career, was living in a rather primitive house in the jungle. He took in a monkey as a pet. Although the naturalist was rather fond of the creature, the monkey had one noisome habit that was somewhat disturbing; when it needed to relieve itself, the monkey did not differentiate between inside and outside. To demonstrate his displeasure when the monkey made a mess on the floor, the naturalist would slap the monkey on the rump and throw him out the window. Being an apt pupil, the monkey learned quickly. After defecating on the floor, he would slap himself on the bottom and jump out the window.

Clearly, the learning process is a complex one. If we want to acquire a mechanical skill, no matter of what type, we must grasp the controls, of whatever sort, and, quite literally, feel what happens when we manipulate that lever, wheel, knob or computer mouse. Initially, we are likely to concentrate on the sensations at the man-machine interface. But, gradually, we become less aware of the immediate sensations and instead direct our attention to controlling the process. Every time I see a photograph of the nearly blind Matisse painting with a brush, the handle of which is perhaps two feet long, I am amazed by the skill exemplified in that process. We all experience similar things, if in less dramatic ways. For example, we who have grown adept at computers attend to the arrow on the computer screen, barely aware of the motion of our hand or the feeling in our fingers which grasp a mechanical mouse. No semantic description is capable of providing us with these skills.

The acquisition of knowledge shares some features with the acquisition of a skill. While there are no tangible knobs, pedals, handles, keys, strings, or whatever, there are controlling principles for which one must acquire a feel. The beginner acquires bits of information, heuristic rules, principles, laws, and sees most problems as special cases. Gradually, experience increases the learner's ability to use that information, provides him with a more comprehensive view, and transforms that information into knowledge. As was the case with skill, no semantic description is adequate to carry out that transformation for us. Neither sage nor text, no matter how useful they may be in this mysterious process, can impart to us the wisdom of the ages. We must rediscover it for ourselves.

As educators, we must give more thought to how we can augment this process of rediscovery. Lectures and textbooks provide a framework and a direction. But it is in the actions taken by the student, when confronting a problem, that an essential part of learning takes place. Such moments hold possibilities for personal discovery. During these moments the student can attempt to construct a model of physical reality that is both personally meaningful and simultaneously in agreement with what the community of experts holds to be true.

In a recent essay in *Computers in Physics*, John Risley listed the general categories for computer use: computer-assisted instruction (some prefer the term computer-assisted learning), computational physics (a short name for a tremendous amount of activity), classroom physics demonstrations, and real-time analysis of laboratory experiments. Within that list, we can assume the implied features of documentation, organization, and legibility.

The number of categories is not great. The number of approaches to problems, however, is probably greater than the number of practitioners. That is as it should be. Just as there can be no best lecturer, or best textbook, or best explanation, there is no "best" way to use the computer in physics education, even for a particular type of problem. Different people use either programming languages, equation-solving software packages, or spreadsheets to solve the same sorts of problems. Each approach has merit. Eventually, perhaps there will be greater uniformity. But for the moment, we are still learning, getting a feel for what seems to be the most useful way to turn the computer into a discovery tool.

The new column "Computers in Physics Education," will present a series of articles describing how physics educators are using computers to encourage the discovery process. At present, the articles will focus on the upper level undergraduate curriculum (above the general physics level) and the beginning graduate level courses. *Computers in Physics* already has a strong track record in providing coverage of educational matters. This column will help to assure a more regular coverage.

I wish to make a request of you the reader. Call me or write to me (either by regular post or electronic mail) to tell me how you are using computers to further physics education. Benefit the physics community; share your experience.

Denis Donnelly is Professor of Physics at Siena College, Loudonville, NY 12211. Office: 518-783-2448; email donnelly@skidmore.bitnet.