IN PROFILE

In Hewitt's Teaching, Equations Take a Back Seat

If life is a random walk, then you might say Paul Hewitt, the successful textbook author, teacher, and champion of the "conceptual" approach to teaching physics, has taken the scenic route.

Growing up in Saugus, Massachusetts, Hewitt had no great love of science. Back then, Hewitt's two great loves were boxing and drawing cartoons. As a boxer, he went as far as taking a silver medal one year in the Flyweight Boxing Championship of the New England States. Art, on the other hand, was to be his career, a plan that a high school counselor endorsed. "I was told that because I was good at art, I wouldn't have to take the academic courses," Hewitt recalls. "So I didn't." Instead, after graduating, he did a two-year stint in the Army, then spent a few years working as a uranium prospector in Colorado, and eventually wound up in Florida painting billboards.

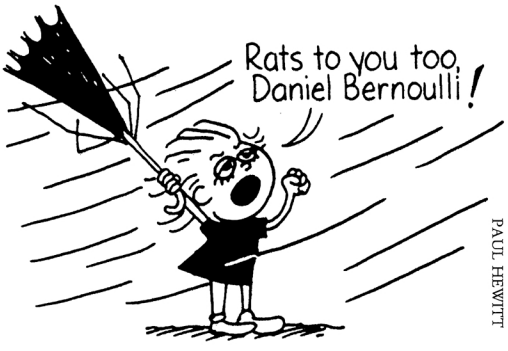
Hewitt's painting partner was a thoughtful and talkative sort named Burl Grey, who liked to pose questions about the natural world and then try to answer them. During their long hours on the scaffolding, the two would ponder issues of science and philosophy. Grey, whose own education had stopped somewhere short of college, encouraged his young partner to go back to school and study physics.

And so, at the age of 27, Hewitt, by then married and a father, enrolled at Lowell Technological Institution (now the University of Massachusetts at Lowell). Although he loved the subject of physics, he was frustrated with the quality of teaching, especially in the large introductory courses. "I thought I could teach just as well, if not better," Hewitt says. "That became my goal. I wanted to inspire the beginning students and get them motivated."

In 1964, having earned a bachelor's degree from Lowell Tech and a master's degree from Utah State University, Hewitt landed his "dream job," teaching physics at City College of San Francisco. The urban junior college catered to students from a wide range of backgrounds, and many of them lacked a solid grounding in math and science. So Hewitt focused his energy on making physics accessible. "I saw my role as that of a translator, translating physics into the language of nonscience students."

During his first few semesters, he used the standard equation-laden approach to teaching physics, taking pains to explain everything clearly and fully. "Unfortunately, I found my clear derivations were not always appreciated," Hewitt says. "I was speaking in a language that was not that of the students."

He decided to try something new. He stripped out much of the applied mathematics and problem solving and focused instead on "the rules of the physical world" and on how physics can explain everyday phenomena. Equations were used sparingly, "as guides to thinking rather than recipes for algebraic manipulation," Hewitt says. "With problem solving minimized, a greater span of physics, from Newton to nuclear, [could be] treated." It helped that the mood on college campuses at the time was conducive to experimentation, he adds. "Students were demanding relevance in their courses." Word spread about Hewitt's new intro physics course, and enrollment soon grew to more than a thousand students a semester, becoming the college's largest elective course.



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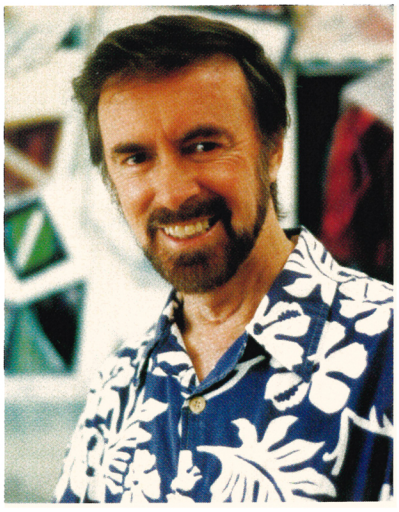
He then set about writing his own textbook. The first edition of Hewitt's *Conceptual Physics* appeared in 1971, and its departure from the ordinary was widely noted. "An excellent book," concluded Kenneth Ford (himself the author of the popular 1960s textbook *Basic Physics*) in a review for this magazine (October 1971, page 54).



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"The physics is sound; the style is light and agreeable. . . . [The questions] appear to be carefully chosen not to frighten average students, the students we rarely see around physics departments but need to see more of." Unlike the dry monotone of most textbook prose, Hewitt's writing had a playful quality. A discussion of impulse and momentum includes this passage: "You know that if a flower pot falls from a shelf onto your head, you may be in trouble. And whether you know it or not, if it bounces from your head, you're certainly in trouble. Impulses are greater when bouncing takes place. . . ."

Not everyone was so pleased, however. One longtime critic is Mario Iona, a professor at the University of Denver and a well-known reviewer of physics textbooks. "I'm in favor of conceptual physics with a small 'c,'" Iona says. "But I think Hewitt doesn't always focus on the main concept involved," which in the flower pot example, he says, would be energy dissipation rather than momentum change. "And he takes the avoidance of mathematics to an extreme." Traditional textbooks, on the other hand, err in the opposite direction, Iona adds. "They're too thick already, so they just show the mathematics. For many teachers, that becomes *the* approach. You don't need calculus to describe to kids the center of mass, say. It's almost intuitive." Other textbook reviewers disagreed over the suitability of Hewitt's philosophical digressions (his discussion of science and religion, for example) and his hand-drawn illustrations.

Those who like Hewitt's approach tend to like it a lot. Paul Doherty, a physicist at the Exploratorium, San Francisco's famously hands-on science museum, says that as a teacher, Hewitt

is uniquely inspiring. "Paul really knows his students, he knows their backgrounds, and he is able to bring them to a strong understanding of the physics." He also praises Hewitt's "wonderful sense of humor. He's willing to laugh at his own mistakes." A charismatic lecturer, Hewitt peppers his talks with questions and demonstrations, occasionally pausing for students to "check your neighbor," to discuss among themselves how and why they arrived at a given answer. His blackboard skills help keep students engaged, Doherty adds. "He'll say, 'Suppose you have a guy in a cart pulled by a horse,' and then he'll actually draw it." (Hewitt has even offered workshops on the basics of physics cartooning at professional meetings.) Doherty, who has taught conceptual physics courses several times, admits that "this is a difficult class to teach. It calls for an array of physics knowledge and human communication skills."

The popularity of *Conceptual Physics* has continued to grow. Now in its eighth edition (which as of May had sold 66 000 copies), the textbook remains "in a class by itself," as a recent review in the *Physics Teacher* put it. The book has been translated into seven languages and spawned a line of related materials, including practice books, CD-ROMs, videotapes, and a Web site. The high school edition, first released in 1987, is now the third most popular high school physics text in the US. Hewitt's "Figuring Physics" cartoons, which pose questions about the physics of everyday situations, are a regular feature in the *Physics Teacher*. His contributions to physics education have been recognized by the American Association of Physics Teachers, which in 1982 awarded him its Robert Millikan Lectureship. "Conceptual physics is mainstream now," Hewitt notes. "But it took 25 years for that to happen. No new idea is accepted by everybody. That's just a fact of life."

Since retiring from full-time teaching last January, Hewitt has been working on a series of guides for parents and elementary school teachers. As for Hewitt's early mentor, Burl Grey, the two lost touch after Hewitt left Florida. Last year, a detective taking Hewitt's course managed to trace Grey to a friend's home in Miami, where he was then living. Hewitt wrote to Grey, thanking him for his inspiration, and enclosed a $10 000 check. After a reunion in San Francisco, Hewitt invited Grey to become the caretaker for his second home in Hilo, Hawaii. Grey accepted, gladly, and he is now writing the epilogue to Hewitt's next book. "Burl is as stimulating as ever," Hewitt says.

JEAN KUMAGAI ■