

Feature Book Review

A Pioneer of Hands-On Education

Review of: *Something Incredibly Wonderful Happens: Frank Oppenheimer and His Astonishing Exploratorium*, by K. C. Cole, with a foreword by Murray Gell-Mann; 2009 (paperback edition: 2012); 330 pp; University of Chicago Press; ISBN: 978-0226113470

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This book is a timely read, coinciding as it does with the moving of the renowned Exploratorium from the Palace of Fine Arts at the foot of the Golden Gate Bridge in San Francisco, where it was established in 1969, to its new and larger location at Pier 15 on the Embarcadero. This institution continues to embody the vision of its founder, Frank Oppenheimer, the subject of this highly personal yet well-documented biography. The author, K. C. Cole, worked with Oppenheimer at the Exploratorium from 1972 until 1985 and in a subsequent voluminous correspondence. Together, they wrote magazine articles, prepared exhibit labels, developed applications for funding, and worked on a book project. The author herself is an ideal narrator, representing the target audience for the Exploratorium itself: the intelligent, curious, nonscientist. She brings the reader along on her voyage of discovery of the process of science through interactions with her enthusiastic and thoughtful guide.

The book's title, *Something Incredibly Wonderful Happens*, is drawn from a piece called "Adult Play," which Oppenheimer wrote for the *Exploratorium* magazine in 1980 (Oppenheimer, 1980). He describes play as activity without a particular goal, just noticing how something works or does not, combining things on a whim and often ending up with nothing in particular, throwing it out, and playing in a different way. "But a research physicist gets paid for this 'waste of time' and so do the people who develop exhibits in the Exploratorium.

Occasionally though, something incredibly wonderful happens." As the embodiment of the ease and freedom of play using exhibits designed to stimulate curiosity and challenge perception, the Exploratorium is precisely the sort of place where such exciting revelations can occur.

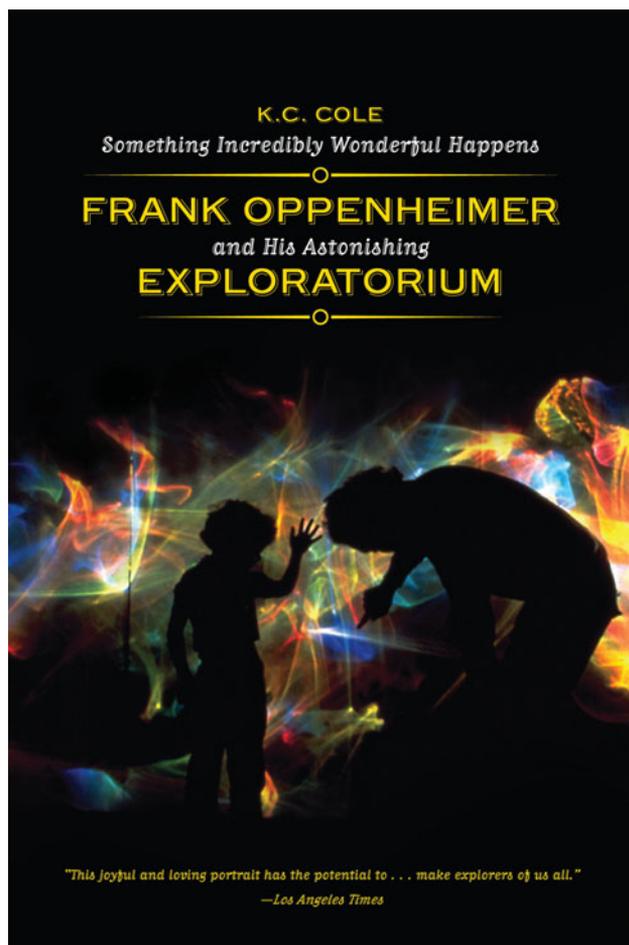
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The originality of the Exploratorium concept, a science museum without rules, encouraging experimentation and hands-on interaction with the exhibits, an environment where it is impossible to fail, grew organically from Oppenheimer's own experiences of science and science teaching and was further informed by his rich background in art and music and his commitment to democracy in access to the riches of the intellectual life. The book thus provides a model for current life sciences educators, a particular view of the style of instruction that is now widely understood to be the most effective way to engage students in the processes of science. In this review, I will focus on those aspects of Oppenheimer's life that most directly led to his approach to informal science education.

The first six chapters describe Oppenheimer's childhood, education, early work as an atomic physicist (including the Manhattan Project, which he worked on with his brother, Robert Oppenheimer), his difficulties during the McCarthy era, and a period of more than a decade in Pagosa Spring, Colorado, where he became a self-taught rancher and science teacher at the local high school. Blacklisted from university employment, he turned to the local community, who welcomed him and shared with him their agricultural expertise while valuing his contributions to the education of their children. A typical event was recalled by his son Michael, in which he and his father dissected a pig's head after the pig had been slaughtered (p. 110). His teaching portfolio included general science, biology, chemistry, and physics. The students were not eager to learn at first, so Oppenheimer came up with intriguing experiments to capture their attention. They took apart machinery, dissected various organisms, explored the rural area and the junkyard, and asked questions. Sports were the preoccupation of most students, but they could involve relatively few students directly, and the emphasis on wins and losses took away much of the fun. Science fairs became a more democratic activity, and the students were unusually successful, bringing notice to Pagosa Springs and further opportunities for its students. In all his dealings with students, Oppenheimer took pains to answer their questions with honesty and rigor while adjusting his approaches to their intellectual maturity. He was not limited by age-appropriate curricula or preconceptions as to what a young teenager could understand. He also began working with teachers to help them develop similarly engaging curricula, a new concept for many of them, for whom science teaching was a threatening challenge. Oppenheimer understood that only excited and engaged teachers could adequately excite their students.

At the end of his time in Colorado, he worked at the University of Colorado, where he undertook a revision of the physics teaching laboratories. In doing so, he developed and improvised instruments to conduct experiments on a wide range of physical phenomena. In this period, he became convinced that grades, particularly the grade of "F," were pernicious and inhibited full creativity and curiosity in students, particularly those whose background was not that of the traditional academic culture. He worked hard to include opportunities for minority students in his courses and noticed how somewhat arbitrary "rules" tended to perpetuate the division between those who were "in" and those who were "out." He also recognized the role of the physical setting in fostering excitement about science; he insisted on open laboratories surrounding lecture space, so the artificial distinction between the two

modes of learning was blurred, and cooperation and conversation could be part of learning. The experiments became a sort of "library," accessible all day long with the same freedom as a library of books.

The first half of the book ends with Oppenheimer's visits to science museums in Europe as a Guggenheim Fellow in 1965. He realized that the context of the science museum, particularly as a means to reach underserved members of the public, would be the best venue for his educational ideas. In the second half of the book, we learn of the development of the Exploratorium itself, designed in every aspect to encourage visitors to play and to be comfortable in their enjoyment of the exhibits, and to help them satisfy their curiosity. Analogous to a walk in the woods during which you notice various aspects of the environment, some large, some small, and take delight in them, the Exploratorium provided a "woods" of natural phenomena, through which visitors could walk, dallying here or there to try out one or another of the exhibits. Though all principles of science were important, an emphasis was placed on those involving direct perception. Aesthetics were important in all the exhibits, and artists were invited to prepare works and installations placed side by side with more traditionally "scientific" exhibits, thus blurring that somewhat artificial distinction. In fact, Oppenheimer was a proficient flautist and grew up in a home rich in art. He, more than most, was acutely aware of the beauty of science and the rigor of art, both ways of probing the human spirit. He is quoted as saying that artists and scientists are the official "noticers" of society (p. 191), an intriguing idea.

A particularly innovative aspect of the Exploratorium was the hiring of students to be Explainers. Not as stuffy or formal as a typical docent, the Explainer's job was to help others use the exhibits, perhaps suggesting ways the apparatus could be manipulated or what important principles it demonstrated. We now call this practice "peer-assisted learning," and recent work has documented its advantages to both the explainer and the explainee.

Another firmly held principle, at least during Oppenheimer's life, was that admission to the Exploratorium should be free of charge. Despite a perennial shortage of funds, this principle was adhered to, guaranteeing that people could drop in from time to time as they might visit a favorite park, for a brief refreshing break or for a longer jaunt. Not only did such practice encourage regular visits, it democratized the institution by removing barriers to participation by those otherwise lacking means.

Ultimately, Oppenheimer's attitude toward science teaching and learning, as embodied in the Exploratorium, was to address two fundamental human needs: curiosity and confidence in one's ability to understand things. It is a teacher's job to get a student "unstuck" (p. 220), to intrigue the student and then to discover what the student already understands and build on it. Throughout, the teacher must reassure students that their brains are working just fine. No one ever fails a science museum.

A final remark for readers of this journal is Oppenheimer's attitude toward assessment. He said, "Why do we insist that there must always be a measure for the quality of learning? . . . By thus insisting we have limited our teaching to only those aspects of learning for which we have devised a ready measure. . . . If we prematurely insist on a quantitative

measure for the effectiveness of museums, we will have to abandon the possibility of making them important" (p. 274). The criterion for evaluation of the exhibits at the Exploratorium was that they not be boring!

In each of the 12 chapters of this book, subheadings are accompanied by pithy quotations from Oppenheimer himself or one of his colleagues. The scholarly apparatus of the book is contained in notes and a bibliography at the end, so it does

not distract from a highly entertaining and edifying read. I recommend this book.

REFERENCE

Oppenheimer F (1980). Adult Play. The Exploratorium. www.exploratorium.edu/files/about/our_story/history/frank/pdfs/adult_play.pdf (accessed 3 July 2013).