PAUL HALMOS

Paul Halmos (March 3, 1916 – October 2, 2006) was one of the most interesting mathematicians of the 20th century. Besides creating brilliant mathematics, he was among the foremost expositors of mathematics of his era. His own estimate is: "I was, in I think decreasing order of quality, a writer, an editor, a teacher, and a research mathematician." Born in Budapest, Hungary, Halmos lost his mother when he was six months old. His physician father foresaw the trouble in store for Europe and emigrated to the United States in 1924, leaving Paul and his two elder brothers behind with the physician who took over their father's practice. In 1929, Halmos' father became an American citizen and had Paul join him in Chicago. There he attended high school, graduating at the age of 15 because of confusion over the number of years of school he had completed in Hungary. He enrolled at the University of Illinois, originally planning to study to be a chemical engineer, but he soon changed to mathematics and philosophy, graduating in only three years. In 1938, he was awarded his PhD from the University of Illinois. The title of his thesis, supervised by Joseph Leo Doob, was *Invariants of Certain Stochastic Transformations: The Mathematical Theory of Gambling Systems*.

Finding a job in a period when the country was still experiencing the effects of the Great Depression was extremely difficult. Halmos sent out 120 letters of application and received only two replies, both rejections. He took it upon himself to attend the Institute for Advanced Study at Princeton, even though he had not been invited and had no fellowship. Six months later he was awarded a fellowship and the following year was made an assistant to his mathematical hero, John von Neumann. As a result of this association, Halmos wrote his first book, *Finite Dimensional Vector Spaces*, inspired by one of von Neumann's courses. The book, which brought Halmos instant fame, is a truly outstanding text, written

in the marvelous style that came to be associated with him.

After he left the Institute, Halmos took a position at Syracuse University then moved to the University of Chicago in 1946 and relocated to the University of Michigan in 1961. In 1968-69, he was the head of the mathematics department at the University of Hawaii. The next year, Halmos went to Indiana University, where with the exception of the years 1975-78, when he was at the University of California at Santa Barbara, he stayed until 1985, when he moved to Santa Clara University. He also was a visiting professor at Montevideo, Miami, Harvard, Tulane, Washington, Berkeley, Edinburgh and Perth. Throughout his career, Halmos has been a demanding but popular teacher, advocating the so-called Moore method, named for American topologist Robert Lee Moore. It is a Socratic question-asking, problem-challenging approach to teaching. It is harder on the instructor than one might suspect, but when students realize that they can learn, and learn more significant mathematics this way, it's very rewarding. In his article "The Problem of Learning to Teach: The Teaching of Problem Solving," *American Mathematical Monthly*, 1975, Halmos wrote:

> "Can one learn mathematics by reading it? I am inclined to say no. Reading has an edge over listening because reading is more active – but not much. Reading with pencil and paper on the side is very much better – it is a big step in the right direction. The very best way to read a book, however, with, to be sure, pencil and paper on the side, is to keep the pencil busy on the paper and throw away the book."

Halmos was a colorful mathematical maverick, whose expository writing contained enough clever and insightful comments on mathematics, on learning mathematics, on teaching mathematics, on writing mathematics and on a carload of other topics about the world to fill a nice size quotation book. His wit and exceptional sense of humor is especially welcomed in a field that many non-mathematicians and a number of mathematicians consider too serious to be amusing. As an illustration there is the oft-told

story of G.P. Hochschild asking Halmos to put his name in his new book. Halmos obliged and in the index appears the entry "Hochschild, G.P. 198," the only mention of Hochschild in the book. The reference 198 is the page in the index where Hochschild's name appears.

In his expository writings Halmos simplifies difficult mathematics by announcing that he is going to lie a little. He can be exceedingly opinionated, which is not appreciated by all. Israeli-American mathematician Doron Zeilberger, now of Rutgers University, took exception to Halmos' article "Applied Mathematics Is Bad Mathematics." Zeilberger numbers his delicious opinions, found on his home page. Opinion 2 is titled "People who believe that Applied Math is Bad Math are Bad Mathematicians." Zeilberger asserts that people like Hardy and Halmos are not really bad mathematicians they are not mathematicians at all because "true" mathematicians respect all mathematics and do not employ arbitrary divisions. At the end, Zeilberger amends his opinion with the following observation that probably made Halmos laugh:

> "On second thought, both Hardy and Halmos are mathematicians. Hardy, in spite of his philosophical errors, is still a great mathematician, even in the broad sense of the word. Halmos is also a good mathematician, he just sometimes says nonsense."

In his mathematical research Halmos made important contributions to operator theory, ergodic theory, and functional analysis. His well-written textbooks include *Measure Theory* (1950), *Introduction to Hilbert Space and the Theory of Spectral Multiplicity* (1951), *Naive Set Theory* (1960), *Algebraic Logic* (1962), *A Hilbert Space Problem Book* (1967), and *Lectures on Boolean Algebras* (1974). He was editor of the *American Mathematical Monthly* from 1982 to 1986 and held similar editorial positions with several other journals. In 1983 Halmos was awarded the Steele Prize for Exposition from the American Mathematical Society and in 1993 a Distinguished Teacher award from the Mathematical Association of America. He was awarded the Mathematical Association of America's Gung-Hu Award

for Distinguished Service to Mathematics in 2000.

Teachers can't always be certain if they are appreciated. After all education is a painful process and it is the duty of teachers to inflict pain. Wise students know that it is by working with their instructors that they learn and understand. Thanking teachers for their help not only makes the teacher's day; it demonstrates that the one doing the thanking really has learned the lesson of how the educational process works. One of my students said, 'Thank you for teaching me many things and a little mathematics." That was more than forty years ago, but his kind remark sustained me many times when being a teacher was difficult to enjoy. Halmos deserves many thanks for his superb textbooks and his delightful comments on mathematics and teaching mathematics.

In 1991, Springer-Verlag published *Paul Halmos: Celebrating 50 Years of Mathematics,* edited by John H. Ewing and F.W. Gehring, honoring Halmos' 75th birthday. It consists of articles about his work as mathematician and broad surveys of his mathematical specialties. The Mathematical Association of America released a video *A Conversation with Paul Halmos*, a candid interview in which Halmos shared his views and reminiscences in 1998. In 2003 Paul Halmos and his wife of 58 years, Virginia, donated $3 million to establish a Mathematical Sciences Conference Center in Washington, D.C.

Quotation of the Day: "I am proud to be a teacher. Teaching is an ephemeral subject. It is like playing the violin. The piece is over, and it's gone. The student is taught, and the teaching is gone…. The best you can do [in explaining mathematics to lay people] is communicate the spirit of mathematics: find the question, look for examples, guess the answer, and go from there. I give talks on problems, not in detail, but at a level that has a chance of reaching them. I try very hard in my writing and in my public speaking to [appear] spontaneous, by which I mean that I prepare everything to within an inch of its life. Every single word that I publish I write at least six times. [I might practice] a talk 20

times. It's important, not because people will pat you on the back and applaud you, but because it contributes to communication – explanation, organization, architecture, and structure. I want to make things clear, and I enjoy trying to understand and clarify mathematics…more even than to discover it." – Paul R. Halmos