

Robert Lee Moore

In many ways **Robert Lee Moore** (November 14, 1882 – October 4, 1974) is an enigma. To many of his students, he was the greatest mathematics teacher of all time and had a vast influence on their mathematical careers and their dedication to spreading the “Moore Method”. The latter is an educational philosophy that Moore himself encapsulated in the statement: “That student is taught the best who is told the least.” To some Moore was a racist, a bigot, and a male chauvinist long before that phrase came into vogue.



That he was a complex character, with many admirable qualities and some abominable ones, makes his story interesting, but its telling is neither an apology for his behavior nor a hatchet job. He was what he was, for reasons that can be analyzed by those who have more time for the endeavor. This brief description of his life and career is only an appetizer not a whole meal. Other sources can provide a more complete investigation of Moore’s legacy, for instance the Spectrum book, published by The Mathematical Association of America, *R.L. Moore: Mathematician & Teacher* (2004) by John Parker.

Moore was born in Dallas, Texas, the fifth of six children of Charles Jonathan and Louisa Ann Moore. Robert Lee’s father moved to Texas at the time of the American Civil War to fight for the Confederacy. After the conflict he settled in Dallas, where he ran a hardware and feed store. Robert Lee attended private schools in Dallas and learned calculus by studying on his own before going on to the University of Texas at Austin at age sixteen. At Texas he came under the influence of George Bruce Halsted, an internationally known mathematician. Moore obtained both his B.S. and M.A. in 1901 and stayed on at the university as a teaching fellow before teaching. In a geometry class Moore proved that one of

Hilbert's axioms in his *Grundlagen der Geometrie* was not independent of the other axioms. This came to the attention of Eliakim Hastings Moore, head of the mathematics department of the University of Chicago. Eliakim, who was not related to Robert Lee, arranged for a scholarship so the latter could study for his doctorate. Robert Lee received his PhD in 1905 for a thesis "Sets of Metrical Hypotheses for Geometry," on the foundations of topology, written under the direction of Oswald Veblen.

For the next fifteen years Moore held several university teaching positions: University of Tennessee (1905 - 1906), Princeton University (1906 – 1908), Northwestern University (1908 – 1911), and the University of Pennsylvania (1911 – 1920). He married Margaret MacLelland Key, in 1910. They had no children. In 1914, Moore became an associate editor of *Transactions of the American Mathematical Society*, continuing in the position until 1927. He returned to the University of Texas in 1920 where he remained until his forced retirement that took place eighteen years after the official retirement age of 70. He taught five courses each semester up until the age of 85. By the time Moore moved to Austin, he had published seventeen papers on point-set topology, a term which he coined. Moore published his research in his only book *Foundations of Point Set Topology* in 1932. It sprang from the colloquium lectures that he gave in 1929 for the American Mathematical Society (AMS). A strong supporter of the AMS, Moore was its president from 1936 to 1938. After the publication of his book, most of Moore's subsequent research was expressed in his teaching and through the work of his students. Fifty of his sixty-eight research publications appeared before 1932.

Moore supervised fifty PhD students, forty-one of whom were awarded their degrees during the period 1932 to 1969. Three of his students R.L. Wilder, G.T. Whyburn, and R.H. Bing, became presidents of the AMS. R.D. Anderson, Edwin Moise, Bing, Wilder, and Gail Young became presidents of the Mathematical Association of America (MAA). In 1967 the American Mathematical Monthly published the results of a survey on the average number of research publications of mathematics PhD's who

graduated between 1950 and 1959. Tulane University took top honors as its mathematics PhD's in the period averaged 6.3 publications. During this time frame Moore's doctoral students averaged 7.1 publications. In 1973 the University of Texas named its new, seventeen-story mathematics, physics, and astronomy building the Robert Lee Moore Hall.

Besides his contributions to point-set topology Moore is most famous for his method of teaching mathematics, which for some who are not enamored of it have described as not teaching mathematics. He passionately believed that students were and should be their own best teacher. Most current theories of learning include the conclusion that higher level cognitive skills are best developed through activities that are directed and carried out by students themselves. Overcoming the belief of many students that they can learn by passively listening to teachers, following their explanations and instructions, is often the most difficult task for those who endorse Moore's belief. Many teachers would feel insecure in using Moore's method, believing that in doing so they have given over control of the course to the students, who might embarrass them by asking questions for which they hadn't planned.

Moore first experimented with his teaching method, which also is known as the "Texas Method," while teaching at the University of Pennsylvania. Students are to prove as many theorems and solve as many problems as possible outside the classroom. For each theorem or problem, one student of those who claim to have succeeded, presents a proof of a theorem or a solution of a problem at the blackboard. As the method is based on competition, students are not permitted to discuss their work outside of class. Moore called on the weaker students first and if any felt they were close to completing the theorem or problem, they were allowed to leave the class so as not to see the blackboard demonstration. If during the demonstration students made a mistake or got lost, they were given the opportunity to correct the mistake or clear up the difficulty. If this didn't happen in a reasonable amount of time, another student is given the chance to give the proof. Throughout the demonstrations, the instructor's role is to be

supportive. Through creative questioning he or she helps the student clarify things.

Moore was patient in his more introductory courses. It might take half of the semester, before students began making good proofs. He was not concerned with covering some given set of material. The method works best in advanced undergraduate and graduate courses. In Moore's advanced seminars some of the problems were open questions, which led to doctoral theses for his students. F. Burton Jones stated that in his graduate topology courses, Moore wanted "to have a class as homogeneously ignorant (topologically) as possible." Moore began classes by explaining his views on the axiomatic method. After stating the axioms and giving a number of examples, he listed a set of definitions and theorems and instructed his pupils to find proofs of their own and construct examples to demonstrate that the "hypotheses of the theorems could not be weakened, omitted, or partially omitted."

It is now time to discuss the less attractive aspects of Moore's personality. The following examples of his racist and bigoted behavior speak for themselves. Walker E. Hunt, who received his PhD from the University of Texas at Austin, reports in his personal statement for *Mathematicians of the African Diaspora* that he was discouraged from enrolling in Moore's famous *Foundations of Point-Set Topology* course because he was black. Hunt is quoted in a web page created and maintained by Scott W. Williams of the Mathematics Department of The State University of New York at Buffalo that Moore told him, "You are welcome to take my course but you start with a C and you go down from there."

On another occasion he attended a topology lecture given by a graduate student of R H Bing, who was one of Moore's most successful and esteemed PhD students. When Moore discovered that the lecturer, his "mathematical grandson," was black he walked out of the lecture. Vivienne Mayes-Malone who received a PhD from the University of Texas-Austin was not allowed to enroll in Moore's course

because he told her he did not teach blacks. Moore didn't hold women and Jews in very high regard, but he did direct the dissertations of six female students, including Mary Ellen Rudin at the University of Texas in 1949.

The author was privileged to study with three of Moore's students, Bing, Young and his cousin Moise. They did not teach mathematics exactly in the manner of Moore, but there was clear evidence of his influence in their teaching. Moise's approach was the closest to the Moore method. Students were encouraged to prove theorems away from class but were not expected to perform before their classmates at the blackboard, nor were they in competition with each other. This may have been because we were high school mathematics teachers participating in a National Science Foundation Summer Institute. It may have been felt we were not sufficiently experienced in mathematics to weather the full Moore treatment.

Quotation of the Day: "Not everyone can be a mathematician, but everyone can want to be a mathematician." – Robert Lee Moore