Devlin's Angle

Sunday, February 1, 2015

The Greatest Math Teacher Ever?

Last month I wrote about the kind of mathematic learning experiences we need to design to prepare young people for life in the Twenty-First Century. I cited the hugely successful, pioneering educational work of the late Professor R L Moore of the University of Texas. This follow up article about Moore and his teaching method is a combination of two earlier Devlin's Angle posts, from May 1999 and June 1999. Other than adding a short paragraph at the end leading to further information about Moore, the only changes to my original text are minor updates to adjust for the passage of time.

The set-up

Each year, the MAA recognizes great university teachers of mathematics. Anybody who has been involved in selecting a colleague for a teaching award will know that it is an extremely difficult task. There is no universally agreed upon, ability-based linear ordering of mathematics teachers, even in a single state in a given year. How much more difficult it might be then to choose a "greatest ever university teacher of mathematics." But if you base your decision on which university teacher of mathematics has had (through his or her teaching) the greatest impact on the field of mathematics, then there does seem to be an obvious winner. Who is it?

Most of us who have been in mathematics for over thirty years probably know the answer. Let me give you some clues as to the individual who, I am suggesting, could justifiably be described as the American university mathematician who, through his (it's a man) teaching, has had the greatest impact on the field of mathematics.

He died in 1974 at the age of 91.

He was cut in the classic mold of the larger-than-life American hero: strong, athletic, fit, strikingly good looking, and married to a beautiful wife (in the familiar Hollywood sense).

He was well able to handle himself in a fist fight, an expert shot with a pistol, a lover of fast cars, self-confident and self-reliant, and fiercely independent.

Opinionated and fiercely strong-willed, he was forever embroiled in controversy.

He was extremely polite; for example, he would always stand up when a lady entered the room.

He was a pioneer in one of the most important branches of mathematics in the twentieth century.

He was a elected to membership of the National Academy of Science, as were three of his students.

The method of teaching he developed is now named after him.

If you measure teaching quality in terms of the product - the successful students - our man has no competition for the title of the greatest ever math teacher. During his 64 year career as a professor of mathematics, he supervised fifty successful doctoral students. Of those fifty Ph.D.'s, three went on to become presidents of the AMS - a position our man himself held at one point - and three others vice-presidents, and five became presidents of the MAA. Many more pursued highly successful careers in mathematics, achieving influential positions in the AMS and the MAA, producing successful Ph.D. students of their own and helping shape the development of American mathematics as it rose to its present-day position of world dominance.

In the first half of the Twentieth Century, fully 25% of the time the president of the MAA was either a student or a grandstudent of this man.

Other students and grandstudents of our mystery mathematician served as secretary, treasurer, or executive director of one of the two mathematical organizations and were editors of leading

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His most recent books are *Introduction to Mathematical Thinking*, *Mathematics Education for a New Era: Video Games as a Medium for Learning* (AK Peters/CRC Press), *The Man of Numbers: Fibonacci's Arithmetic Revolution* (Walker & Co), and an e-book short *Leonardo and Steve: The Young Genius Who Beat Apple to Market by 800 Years*.

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MAA

mathematical journals.

After reaching the age of 70, the official retirement age for professors at his university, in 1952, he not only continued to teach at the university, he continued to teach a maximum lecture load of five courses a year - more than most full-time junior faculty took on. He did so despite receiving only a half-time salary, the maximum that state regulations allowed for someone past retirement age who for special reasons was kept on in a "part-time" capacity.

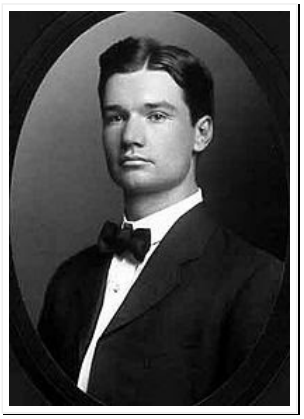
He maintained that punishing schedule for a further eighteen years, producing 24 of his 50 successful Ph.D. students during that period.

He only gave up in 1969, when, after a long and bitter battle, he was quite literally forced to retire.

In 1967, the *American Mathematical Monthly* published the results of a national survey giving the average number of publications of doctorates in mathematics who graduated between 1950 and 1959. The three highest figures were 6.3 publications per doctorate from Tulane University, 5.44 from Harvard, and 4.96 from the University of Chicago. During that same period, our mathematician's students averaged 7.1. What makes this figure the more remarkable is that our man had reached the official retirement age just after to the start of the period in question.

Who was he?

The answer



His name is Robert Lee Moore. Born in Dallas in 1882, R. L. Moore (as he was generally known) stamped his imprint on American mathematics to an extent that only in his later years could be fully appreciated.

As I noted earlier, during 64 year career, the last 49 of them at the University of Texas, Moore supervised fifty successful doctoral students. Three of them went on to become presidents of the AMS (R. L. Wilder, G. T. Whyburn, R H Bing) — a position Moore also held -- and three others vice-presidents (E. E. Moise, R. D. Anderson, M. E. Rudin), and five became presidents of the MAA (R. D. Anderson, E. Moise, G. S. Young, R H Bing, R. L. Wilder). Many more pursued highly successful careers in mathematics, achieving influential positions in the AMS and the MAA, producing successful Ph.D. students of their own -- mathematical grandchildren of Moore -- and helping shape the development of American mathematics as it rose to its present-day dominant position. That's quite a record!

In 1931 Moore was elected to membership of the National Academy of Science. Three of his students were also so honored: G. T. Whyburn in 1951, R. L. Wilder in 1963, and R H Bing in 1965.

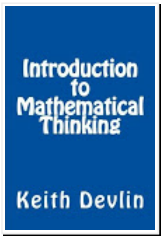
In 1973, his school, the University of Texas at Austin, named its new, two-winged, seventeen-story mathematics, physics, and astronomy building after him: Robert Lee Moore Hall. This honor came just over a year before his death. The Center for American History at the University of Texas has established an entire collection devoted to the writings of Moore and his students.

Discovery learning

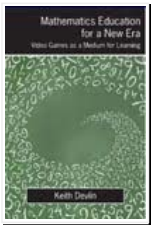
Moore was one of the founders of modern point set topology (or general topology), and his research work alone puts him among the very best of American mathematicians. But his real fame lies in his achievements as a teacher, particularly of graduate mathematics. He developed a method of teaching that became widely known as "the Moore Method". Its present-day derivative is often referred to as "Discovery Learning" or "Inquiry-Based Learning" (IBL).

One of the first things that would have struck you if you had walked into one of Moore's graduate classes was that there were no textbooks. On each student's desk you would see the student's own notebook and nothing else! To be accepted into Moore's class, you had to commit not only not to buy a textbook, but also not so much as glance at any book, article, or note that might be relevant to the course. The only material you could consult were the notes you yourself made, either in class or when working on your own. And Moore meant alone! The students in Moore's classes were forbidden from talking about anything in the course to one another -- or to anybody else -- outside of class. Moore's idea was that the students should discover most of the material in the course themselves. The teacher's job was to guide the student through the discovery process in a modern-day, mathematical version of the Socratic dialogue. (Of course, the students did learn from one another during the class sessions. But then Moore guided the entire process. Moreover, each student was expected to have attempted to prove all of the results that others might present.)

Moore's method uses the axiomatic method as an instructional device. Moore would give the students the axioms a few at a time and let them deduce consequences. A typical Moore class



Introduction to Mathematical Thinking



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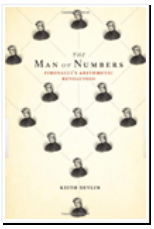

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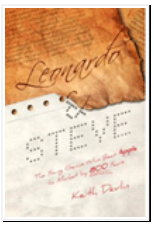

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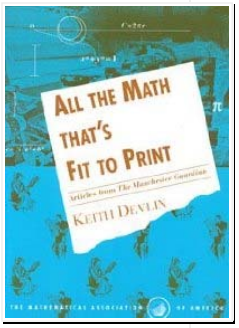

All the Math That's Fit to Print

might begin like this. Moore would ask one student to step up to the board to prove a result stated in the previous class or to give a counterexample to some earlier conjecture -- and very occasionally to formulate a new axiom to meet a previously identified need. Moore would generally begin by asking the weakest student to make the first attempt -- or at least the student who had hitherto contributed least to the class. The other students would be charged with pointing out any errors in the first student's presentation.

Very often, the first student would be unable to provide a satisfactory answer -- or even any answer at all, and so Moore might ask for volunteers or else call upon the next weakest, then the next, and so on. Sometimes, no one would be able to provide a satisfactory answer. If that were the case, Moore might provide a hint or a suggestion, but nothing that would form a constitutive part of the eventual answer. Then again, he might simply dismiss the group and tell them to go away and think some more about the problem.

Moore's discovery method was not designed for -- and probably will not work in -- a mathematics course which should survey a broad area or cover a large body of facts. And it would obviously need modification in an area of mathematics where the student needs a substantial background knowledge in order to begin. But there are areas of mathematics where, in the hands of the right teacher -- and possibly the right students -- Moore's procedure can work just fine. Moore's own area of general topology is just such an area. You can find elements of the Moore method being used in mathematics classes at many institutions today, particularly in graduate courses and in classes for upper-level undergraduate mathematics majors, but few instructors ever take the process to the lengths that Moore did, and when they try, they rarely meet with the same degree of success.

Part of the secret to Moore's success with his method lay in the close attention he paid to his students. Former Moore student William Mahavier (now deceased) addressed this point:

"Moore treated different students differently and his classes varied depending on the caliber of his students. . . . Moore helped his students a lot but did it in such a way that they did not feel that the help detracted from the satisfaction they received from having solved a problem. He was a master at saying the right thing to the right student at the right time. Most of us would not consider devoting the time that Moore did to his classes. This is probably why so many people claim to have tried the Moore method without success."

Another famous (now deceased) mathematician who advocated -- and has successfully used -- (a modern version of) the Moore method was Paul Halmos. He 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 the book away."

Of course, as Halmos went on to admit, such an extreme approach would be a recipe for disaster in today's over-populated lecture halls. The educational environment in which we find ourselves these days would not allow another R. L. Moore to operate, even if such a person were to exist. Besides the much greater student numbers, the tenure and promotion system adopted in many (most?) present-day colleges and universities encourages a gentle and entertaining presentation of mush, and often punishes harshly (by expulsion from the profession) the individual who seeks to challenge and provoke -- an observation that is made problematic by its potential for invocation as a defense for genuinely poor teaching. But as numerous mathematics instructors have demonstrated, when adapted to today's classroom, the Moore method -- discovery learning -- has a lot to offer.

If you want to learn more about R. L. Moore and his teaching method, check out the web site: http://legacyrlmoore.org/.

But before you give the method a try, take heed of the advice from those who have used it: Plan well in advance and be prepared to really get to know your students. Halmos put it this way:

"If you are a teacher and a possible convert to the Moore method ... don't think that you'll do less work that way. It takes me a couple of months of hard work to prepare for a Moore course. ... I have to chop the material into bite-sized pieces, I have to arrange it so that it becomes accessible, and I must visualize the course as a whole -- what can I hope that they will have learned when it's over? As the course goes along, I must keep preparing for each meeting: to stay on top of what goes on in class. I myself must be able to prove everything. In class I must stay on my toes every second. ... I am convinced that the Moore method is the best way to teach there is -- but if you try it, don't be surprised if it takes a lot out of you."

There is a caveat

When I wrote those two Devlin's Angle posts back in 1999, I debated with myself whether to address a side to the Moore story that, particularly from a late Twentieth Century perspective, does not stand to his credit. The issue is race.

Moore's racial attitude was nothing unusual for a white person who was born and lived most of

his life in Texas in the late Nineteenth Century and the first three quarters of the Twentieth. When the Civil Rights Act was passed in 1964 (yes, that recently!), making racial discrimination illegal, Moore was already long past retiring age, and just five years short of actually vacating his university office. Moreover, no one who regularly reads a newspaper would believe that racial discrimination in America is a thing of the past. Moore's racial views are still not unusual in Texas and elsewhere.

Were Moore not such a towering figure, his position on race (at least as demonstrated by his actions) would not merit attention. But like all great people, all aspects of his life become matters of scrutiny. Moore could have acted differently when it came to race, even back then, in Texas, but he did not. And from today's perspective, that inevitably leaves an uncomfortable stain on his legacy.

In writing my two 1999 columns, I chose to focus on Moore the university teacher, in particular to raise awareness of discovery learning in mathematics. The focus of Devlin's Angle is, after all, mathematics and mathematics teaching. I did not want to distract from that goal with what is clearly a side issue, particularly such an explosive one. Moore's larger-than-life character was clearly a significant part of his success. His racism (or at least racist behavior) was not a part of that success story – if for no other reason than because he never accepted any Black students. So I did not raise the issue.

For the same reason, I have left this side of the Moore story to the end here. We can learn from Moore when it comes to designing good mathematics learning experiences, and even admire him as a highly gifted teacher, without condoning other aspects of his life, just as we can enjoy Wagner's music without endorsing Nazism. I can however leave you with a pointer to an article posted online by Mathematics Professor Scott Williams on 5/28/99, about the same time my articles appeared (and possibly in response to the first of them). Like it or not, Williams' post shines light on another side to the Moore story. We can learn things from great people in ways other than taking a class from them, and we can perhaps learn things they were not trying to teach us.

References

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1 comment:

Hector Flores said...

There is one place when we (at least I) use a very similar approach...
the Mathematical Olympiads.
The only significant difference is that sometimes I encourage the communication of ideas between participants after they spend some serious time trying to solve the problem by themselves (and before going to the blackboard).
Thanks Keith this is a great topic. :)

February 24, 2015 at 6:18 PM

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