



Building for the Future: Where We Are and the Next Steps

Innovations for STEM Education

For nearly 20 years, Mr. Harry Lucas, Jr. and the Educational Advancement Foundation have supported inquiry-based learning (IBL) in mathematics at the collegiate level by providing start up funding for innovative programs nationwide. A key goal has been to improve students' early experience with mathematics and retain STEM (Science Technology Engineering and Mathematics) students during their critical initial experience with mathematics classes. The foundation's investments in IBL have helped establish a vibrant IBL community of practitioners and experts. However, due to the critical need to improve STEM education in the US, the philanthropic community must build on this current foundation. EAF is partnering with organizations to expand the use of active learning strategies in STEM education.

In IBL classrooms students are taught through expert guidance how to develop mathematical ideas on their own, either individually or in small groups. They learn how to be producers, rather than just consumers, of knowledge.

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Reminders of the 2013 Legacy conference in Austin, where the next, 2015, conference will also be held.

From the top: a plenary session; Julian Fleron; a roundtable discussion group; Ruthmae Sears; keynote speaker Coke Reed with John Neuberger.



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IBL programs

Conferences – A national IBL mathematics meeting continuing the legacy of R. L. Moore, a University of Texas professor who taught and inspired generations of mathematicians and industry leaders. The annual conference, co-sponsored with the Mathematical Association of America and celebrating 18 years in 2015, brings together more than 200 IBL practitioners and newcomers to share experiences and support program development efforts.

Centers—For ten years, four IBL university based centers have developed classes, introduced regional training programs and inspired a new generation of IBL-trained teachers serving the university, graduate and K-12 levels.

Assessment—A recent three-year study led by Sandra Laursen and the Ethnography & Evaluation Research group at the University of Colorado, Boulder, highlighted improved student outcomes - especially for women and other under-served populations. Follow up efforts aim to disseminate findings and build on the initial study.



The University of California, Santa Barbara, center, under William Jacob's guidance, has been particularly effective in K-12 teacher preparation.

Other centers have been established in the mathematics departments at the University of Texas at Austin and at the University of Chicago.



The University of Michigan, Ann Arbor, has built up a broad variety of undergraduate IBL courses in mathematics and supports the Paul Halmos Visiting Professorship.

Network—EAF supported the development of the Academy of Inquiry-Based Learning (AIBL), currently led by Stan Yoshinobu at Cal Poly San Luis Obispo. AIBL sponsors a small grants program, conducts IBL workshops, and provides a key national website and database to connect IBL practitioners. Funding for the workshops was also provided directly by National Science Foundation grants.

Teaching Materials—EAF has supported the dissemination of new curriculum and suggestions for teaching innovations through articles in the *Journal of Inquiry-Based Learning in Mathematics*, AIBL, the EAF newsletter and the Legacy web site (LegacyRLMoore.org).

Annual grants - Each year, the EAF trustees review grant proposals and fund IBL projects that best extend training and educational activities. In addition to supporting small to mid-sized programs, EAF and Mr. Lucas have also been instrumental in supporting various broader educational efforts, such as the UTeach program and Freshman Research Initiative at the University of Texas.

Historic and Educational Resources—Through a number of programs and initiatives, EAF has enabled the archival preservation of key professors' experiences with IBL and other educational approaches. Through its support of an archivist for the Archives of American Mathematics, EAF helps

to ensure that the records of the Mathematical Association of America and of many individual mathematicians are made available for researchers. Recent goals include making existing materials, including films and photographs, more accessible on the internet.

More details on the programs can be found on the EAF website.

Future goals

Broadened support—These IBL programs have proven themselves worthy of support from other sources than EAF. Indeed, support has been given by, for example, the universities where the centers are located and by the National Science Foundation.

Larger scale impact—With additional support, these programs are capable of being scaled up to a national level. The aim is to play a major role in making an IBL experience a part of the education of all students.



Faculty from STEM disciplines at **Berry College** have participated over the years in Legacy conferences. Berry is known for its campus-wide IBL and active learning ethos.



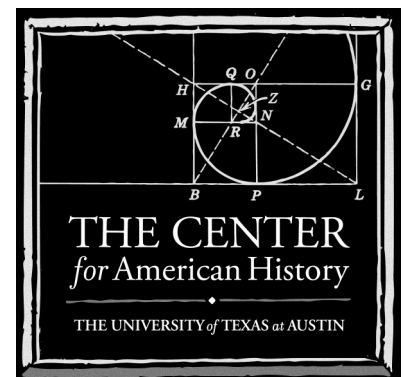
From the top:
Nathaniel Dean
David Bressoud and Mike Starbird

*Photos from the 13th Annual
Legacy of R.L. Moore
Conference, Austin, 2010.*

Next steps

Connect to other organizations—Universities, professional societies, and foundations are examples of possible partners. For example, several such institutions have been approached concerning their interest in establishing a national center or institute for the support and promotion of IBL in mathematics across the country.

Archives of
American
Mathematics



Resources: IBL Classroom Videos

A master teacher's class can serve as a model for aspiring teachers. Unfortunately, it is rare to find video records of such classes freely available, and even rarer to have the video presented in a context that supports in-depth analysis of the teaching and learning taking place.

It is, thus, especially valuable to have a class, "Foundations of Analysis," taught by William S. Mahavier, brought to life on the web with commentary, student background, course material, exams, and the professor's diary.



"Mahavier encourages Valero to attempt Problem 41 [If M is an infinite and bounded point set, then M has a limit point.] She does not have it, but he allows an eight-minute exploration while two students think and talk about the problem, without success." (Day 17)

"Then, even as the class believes the proof is complete, Mahavier adds a problem, Problem 10.5 ... , to the notes and wants Winterhalter to complete this problem during the next class period, rather than allow another student, who has already had success, resolve the problem today. Thus, he reserves this problem for Winterhalter for the next class. This shows how Mahavier tailors the class to individual students." (Day 5)

The course was given at Emory University in 2008. Mahavier (1930-2010), a student of R.L. Moore (PhD 1957), developed his own version of the "Moore Method" over a long and distinguished career teaching at the Illinois Institute of Technology, the University of Tennessee and Emory.

As a bonus, the producer of this web edition of his father's class, W. Ted Mahavier, has made available in the same carefully crafted fashion, recordings from his own class in analysis. While father and son may be in the same Moore tradition, it is instructive to see how the son modified the method to meet the needs of students at a regional university as compared to the private university at which his father taught.

There are links to the videos at:

LegacyRLMoore.org/method.html

A Gift to the Future

The Foundation is grateful for recent contributions from individuals. Such gifts help to shape our response to the urgent need to improve student performance in science, technology, engineering, and mathematics. Guided inquiry, as part of the total learning environment, improves students' creativity and problem solving abilities. Your support will help us increase the impact of our existing programs and extend efforts to new initiatives.

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