PROGRAM

15th Annual Legacy of R.L. Moore Conference

June 14 – 16, 2012, Austin, TX

(Revised May 22, 2012)

Thursday June 14, 2012

10 am – 1 pm Registration

1 – 1:15 pm Welcome and overview

Jacqueline Jensen-Vallin

1:15 – 1:45 **Lee Mahavier-Peterman, Atlanta, GA**

Moore Method for the Masses: Illustrations of Success with Public School 9th Graders

Abstract: It has been well documented that Moore Method is highly effective in university settings and with hard-working students. We will demonstrate that it is also a successful way to teach high school students, including under-prepared and unmotivated ones. What does Moore Method really look like in a ninth grade public school math class? What does the teacher actually do in the classroom? How do you know this works? Here we will explore these questions while illustrating key elements of Moore Method with real-life examples from the 2011-2012 school year.

1:50 – 2:30 **Patrick Bahls, University of North Carolina – Asheville**

Asking the Right Questions: Authentic Inquiry in Research and Education

Abstract: As scholars of mathematics we recognize that in our research the ability to ask good questions is as critical a skill as the ability to answer them. Inquiry-based learning can give us a means of helping our students engage in research, for through our IBL pedagogies we give our students good models for authentic questioning. Through IBL we show them that mastery of even the most mundane mathematical tasks involves a process of discovery, paving the way for their entry into our disciplinary community of scholars. In my presentation I will lead a discussion in which we build a bridge between the IBL classroom and the processes that underlie our, and our students', efforts at original research. Participants are kindly asked to come with one or two current research projects in mind, preferably ones involving (or potentially involving) undergraduates.

2:35 – 3:30 **Panel: Encouraging excellence in education: CUPM Curriculum Guide 2015**

Moderators: **Carol Schumacher (Kenyon College) and Michael Starbird (University of Texas at Austin), members of the Curriculum Guide Steering Committee**

Panelists:

Martha Siegel, Towson University, chair of the Curriculum Guide Steering Committee
David Bressoud, Macalester College, member of the Curriculum Guide Steering Committee
Michael Pearson, Executive Director of the MAA
Beth Borroughs, Montana State University and chair of COMET

Abstract: Every decade or so the Committee for the Undergraduate Program in Mathematics (CUPM) of the MAA writes a curriculum guide to help mathematics departments evaluate and improve their curricula. The last curriculum guide was released in 2004; planning for the next guide is under way. The CUPM and several other MAA committees are structured to encourage discussion of effective practices both in terms of content choices and pedagogical approaches. Recent scholarship on teaching and learning supports the idea that active learning is central to the process of learning mathematics. Panelists will describe the goals of the MAA and CUPM in the creation of the guide. The presentation will be followed by an open discussion of ways in which IBL can (or should!) inform the work of the Curriculum Guide Steering Committee.

3:30 – 3:45 Break

3:45 – 4:30 **New Users Panel – Geometry**

Moderator and Organizer – David Clark, SUNY – New Paltz

Panelists:

Judith Covington, LSU at Shreveport
Todd Gundmeier, California Polytechnic Institute
Gary Richter, Southwestern University
Keith Voss, The Lawrenceville School

4:45 – 5:40 Round Table Discussions – How to use IBL in different settings

And Contributed Paper Sessions. See below for titles and abstracts.

5:30 – 6 Free Time

6 – 7 Reception – Cash Bar

7 – 9 Dinner and Banquet Speaker

Jonathan Hodge, Grand Valley State University

Inquiry, Authority, and Democracy

Abstract: Traditional pedagogies often emphasize the authority of the instructor rather than empowering students to become independent and autonomous learners. In this talk, we will explore ways in which inquiry-based learning can be used to establish more democratic and less authoritarian learning environments. Drawing on research from social psychology, we will consider the potential of inquiry-based learning to promote the habits of mind that are essential to both civil discourse and constructive engagement in society.

Friday, June 15, 2012

7:30 – 8:30 Continental Breakfast

8:30 – 9:00 **Diana White, University of Colorado Denver**

Math Teachers' Circles: Inquiry Based Learning for Practicing Teachers

Abstract: Inquiry based learning is a teaching method that engages students in sense-making activities. Specifically, students are given tasks requiring them to solve problems, pose problems, conjecture, experiment, explore, create, and communicate...all those wonderful skills and habits of mind that mathematicians engage in regularly. We are familiar with a myriad of approaches to this at the undergraduate and graduate levels. However, to systematically reform mathematics education in this country will require also addressing K-12 mathematics instruction. Many K-12 teachers find teaching in an inquiry-based format to be a daunting task, as most only ever experienced learning mathematics in a primarily procedural, lecture-based format. However, the new Common Core State Standards place a high value on mathematical practices and sense making. Thus, there is a strong need for mathematical professional development for practicing teachers that supports them in becoming more conversant with the mathematical practices.

The Math Teachers' Circle program, developed by the American Institute of Mathematics in 2006, aims to meet this need by providing an innovative form of professional development in which mathematicians directly facilitate mathematical problem solving sessions with middle school teachers. In this talk, we describe a typical Math Teachers' Circle, showing why it can be considered an ideal form of inquiry based learning for practicing teachers, describing preliminary research results, and detailing how conference attendees can get involved with this program.

9:05 – 9:35 **James Epperson, University of Texas – Arlington**

The Role of Inquiry-based Learning and Metacognition in Emerging Scholars Programs

Abstract: The design of Emerging Scholars Programs (ESP) or Treisman-style Programs responds to Uri Treisman's research from the late 1970s and early 1980s examining differences in student performance in calculus. To improve student success in calculus, ESPs use the mathematics as an anchor to build community around shared academic interests and encourage effective collaboration. We will explore how inquiry-based learning plays a central role in fostering the collaboration and challenge that permeate the ESP model and highlight the role of metacognition in this learning environment.

9:35 – 10:05 Break

10:05 – 10:45 Five minute talks, Session I

Including a discussion of available resources with

Stan Yoshinobu & **Mark Stankus** – **AIBL &Visiting Speakers' Bureau**

Ted Mahavier – JIBLM

10:50 – 11:20 **Karen Rhea, University of Michigan**

IBL-y Calculus

Abstract: When thinking about IBL in introductory classes, there are many things to consider: the necessary syllabus of the courses, the expertise and training of instructors, the goals and expectations of the students and the institution. For many of us, introductory classes present a particular challenge on every level. In this talk, we will explore an introductory class model that encourages an interactive-engaged classroom for ~5000 students per year, how the style is supported, and the reasons why we believe that model is an important support for the goal of our courses.

11:25 – 11:55 **POGIL (Jill Guerra and Catherine Beneteau)**

12 – 1 Lunch

1 – 1:45 **Experienced User Panel: Dealing with Challenges of IBL**

Moderator and Organizer: Stan Yoshinobu

Panelists:

David Clark, SUNY – New Paltz
Brian Katz, Augustana College
Lee May, Salisbury University
Carol Schumacher, Kenyon College

1:55 – 3:10 Five minute talks, Session II

3:10 – 3:30 Break

3:30 – 4:00 **David Bressoud, Macalester College**

Characteristics of Successful Programs in College Calculus: Preliminary Findings

Abstract: In the fall term of 2010, the Mathematical Association of America undertook a large-scale survey of instruction of mainstream Calculus I in two- and four-year undergraduate programs. The surveys of course coordinators, instructors, and students involved 168 colleges and universities, 660 instructors representing almost 900 Calculus I classes, and over 34,000 students, 12,000 of whom answered the initial student survey. This will be a preliminary report of some of the findings.

4:10 – 5:30 Contributed Paper Session, including a demonstration session about Math Teachers' Circles. See below for abstracts.

Saturday, June 16, 2012

7:30 – 8:30 Continental Breakfast

8:30 – 9:00 **Sandra Laursen**

Navigating the Straits: Critical Teaching Decisions in IBL Instruction

Abstract: Interview data from 44 experienced and novice IBL instructors illuminate the decisions that instructors make as they navigate their way through an IBL course. In the dynamic environment of an IBL classroom, certain instructional dilemmas become more explicit, more salient, and seem more sensitive to instructor choices and student responses to them. While instructors often craft personal solutions to these teaching dilemmas, the dilemmas themselves are common across a variety of courses and student audiences. They encompass both choices made before a course begins and choices made during the course, sometimes on the fly, in an instructor's behavior and responses to student actions. I will discuss why some teaching decisions become "critical" during an IBL course and offer a framework that instructors can use to think - in advance - about their choices as they plan and teach an IBL course.

9:00 – 10:00 **Ron Douglas and IBL Centers**

10:00 – 10:20 Break

10:25 – 11:15 Five Minute Talks, Session III

11:15 – 11:45 **Panel: Using IBL in service courses**

Moderator: E. Lee May

Panelists: Jacquelin Jensen-Vallin, Slippery Rock University

Elwood Parker, Guilford College
Christine van Reneese, Westfield College

11:45 – 12 Concluding Remarks

Jacqueline Jensen-Vallin

Schedule of Contributed Talks

Thursday 14 June

Time	*Omni C,D,E,F* *(Misc)* ***Moderator: Joyati Debnath***	*Conference Center* *(Calculus/Analysis)* ***Moderator: Rachel Schwell***	*Omni A,B* *(Math Ed.)* ***Moderator: Stan Yoshinobu***	*Southpark A,B* *(Misc)* ***Moderator: Dylan Retsek***
4:45 – 5:00	*Violeta Vasilevska:* ***Active Learning Strategies***	*Brandy Comer, et. al:* ***The Moore Method Apprenticeship Program at Lamar University***	*Kelly Bubp, et. al.:* ***Connections between Mathematics Education Research and RL Moore's Legacy***	*William Donnell:* ***Slip and Slide Method of Factoring Trinomials with Integer Coefficients over the Integers***
5:05 – 5:20	*Banning Lary:* ***Distance Learning: IBL thrives in the Online Pedagogical Environment***	*Brandy Comer, et.al.:* ***The Moore Method Apprenticeship Program at Lamar University***	*Mesa and Whittemore:* ***Concerns About Teaching Mathematics with IBL Methods***	*Elwood Parker:* ***IBL…Without a Mathematician in Sight***
5:25 – 5:40	*Ryan Dunning:* ***Preliminary Evaluation of an IBL Introduction to Proof Course for Humanities Majors***	*Dana Ernst:* ***Effective and Efficient Grading for an IBL Course***	*Brian Katz:* ***Higher-Order Tasks in an IBL Course***	*John Mayer, et. al:* ***Euclidean Geometry Rediscovered***

Friday 15 June

Time	*Omni C,D,E,F* ***Organizer: Brian Katz***	*Conference Center* *(Calculus/Analysis)* ***Moderator: Ryan Dunning***	*Omni A,B* *(Proofs)* ***Moderator: Dana Ernst***	*Southpark A,B* *(Math Teachers' Circles)*
4:10 – 4:25	*Roundtable A*	*Brie Finegold* ***Teaching Undergraduate Topology with the Moore Method***	*Rachel Schwell and Roger Vogeler:* ***Modified Moore Method in Discrete Math***	Paul Zeitz, Altha Rodin, and Tatiana Shubin: ***Math Teachers' Circle Demonstration***
4:30 – 4:45	*Roundtable A, continued*	*Scott Beaver:* ***Reflections on a Self-Paced Complex Analysis Course***	*Dylan Retsek:* ***Chop Wood, Carry Water, Use Definitions***	
4:50 – 5:05	*Roundtable B*	*Robert Vallin:* ***Presentation Fridays in Advanced Calculus***	*Susan Crook:* ***How Important is the Final Answer?***	
5:10 – 5:25	*Roundtable B, continued*	*Joyati Debnath:* ***Measure Theory for Undergraduates via IBL Method***	*Annie Selden and John Selden:* ***Mathematical and Non-Mathematical University Students' Proving Difficulties***	

Abstracts for Contributed Talks

Scott Beaver, Western Oregon University

Reflections on a Self-Paced Complex Analysis Course

Abstract: In Spring term 2012, I offered Complex Analysis presented in a modified emporium model at Western Oregon University. Supporting material was available online for the students, and class time was reserved for working on exercises and proofs. The course was self-paced. The layout of the course will be presented, and I will offer an analysis of the efficacy of this model in the setting of Complex Analysis.

Kelly M. Bubp, Gregory D. Foley, Michael A. Smith, Ohio University

Connections between Mathematics Education Research and R. L. Moore's Legacy

Abstract: Recent research in mathematics education has delved into three areas of investigation that are at the heart of what makes the Moore method an effective means for mathematical education: (a) engaging learners in cognitively demanding mathematical tasks, (b) promoting precise and high-level mathematical discourse in the classroom, and (c) using ongoing assessment of mathematical understanding to advance student learning. This talk will report on research findings in these areas and illustrate how each of these is a major tenet of the Moore method.

Brandy Comer, Chris Sams, and Kimberly Wesberry , Lamar University

The Moore Method Apprenticeship Program at Lamar University

Abstract: Three students participated in Lamar University's M2AP program at Lamar this year. After a brief overview of the program by one of the project investigators, the students will each describe their decision to return to graduate school and their experiences with the program after the completion of their first year.

Susan Crook, North Carolina State University

How important is the final answer? Using IBL in an introductory proofs course.

Abstract: Students enter their intro proofs course accustomed to being able to check their final answers with others and in the back of the book. In my opinion, one of the greatest difficulties encountered in teaching proofs is helping students adapt to the idea that there are many correct answers. While in computation-based courses, most students can memorize algorithms and do satisfactorily on tests, a certain level of understanding is required to create a correct proof. While teaching my first intro proofs course and my first IBL course, I often fought with when to assist students and when to let them struggle just a bit longer on a proof. The line between frustration and giving up can be hard to see until your students have crossed it. In IBL classes it can be especially hard to figure out how to give input without positioning yourself as the authority on the subject. I will discuss my observations on the issue and what worked for me in my class.

Joyati Debnath, Winona State University

Measure Theory for undergraduates via IBL method

Abstract: I just finished teaching second semester of real analysis course using a hybrid version of IBL method. I will discuss my experience of this method while teaching this course and the reactions of students with the topics, concepts, proving theorems and finding examples and counterexamples.

William A. Donnell, University of Texas – Pan America

Slip and Slide Method of Factoring Trinomials with Integer Coefficients over the Integers

Abstract: In intermediate and college algebra courses there are a number of methods for factoring quadratic trinomials with integer coefficients over the integers. Some of these methods have been given names such as: Trial and Error, Reversing FOIL, AC Method, Middle Term Splitting Method, and Slip and Slide Method. The purpose of this short talk is to explain the Slip and Slide Method and propose a related Inquiry-Based Learning project.

Ryan Dunning, St. Mary's University

Preliminary Evaluation of an IBL Introduction to Proof Course for Humanities Majors

Abstract: In this talk, I will discuss my experience using IBL in math for the liberal arts. While other liberal arts math courses focus on application-oriented topics, I chose to focus on the language of logic and proof. I will share the preliminary results of entrance and exit surveys (modified from a survey by A. Schoenfeld), aimed mainly at tracking changes in students' beliefs about mathematics. Comparisons will be made to responses from students in College Algebra, the other common terminal math course for humanities majors at St. Mary's University.

Dana Ernst, Plymouth State University

Effective and efficient grading for an IBL course

Abstract: In this talk, we will relay one possible approach to grading for an IBL course. In particular, we will focus on the grading of written homework for undergraduate proof-based courses such as Introduction to Proof, Abstract Algebra, Number Theory, and Real Analysis. The speaker will also attempt to solicit additional ideas and approaches from the audience.

Brian P Katz, Augustana College

Higher-Order Tasks in an IBL Course

Abstract: Many proponents of IBL make claims that students in IBL courses spend more time doing higher-order tasks than in other courses. During this term, I have been asking my IBL Modern Geometry students to report on the amount of time they have been spending on the coursework, what percentage of that work they think falls at each of the levels of Bloom's Taxonomy, and how those percentages compare to the percentages in other courses on campus and in the department. At the end of the term, I will also ask the students to connect particular course activities with the Bloom's level of tasks they require. In this talk, I will share a preliminary analysis of the student responses.

Banning Lary

Title: TBA

John C. Mayer, William O. Bond, and David J. Cosper, University of Alabama at Birmingham

Euclidean Geometry Rediscovered

Abstract: For many students of the first author's generation, particularly the visual thinkers, Euclidean geometry was the first course in which the beauty of mathematics became apparent. The idea that this wealth of knowledge could be deduced from a small set of truths (the axioms) was exhilarating. In his Introduction to the Instructor Edition of his notes, *Euclidean Geometry – a Guided Inquiry Approach*, David M. Clark explains the reasons for, and laments, the loss of this beauty to generations of students; his notes are the remedy. My assistants and I rediscovered geometry, along with our students, through teaching an undergraduate Euclidean geometry course in the Fall 2011 semester based upon David Clark's notes. The notes support an inquiry-based learning approach to axiomatic geometry, which Clark and I would both trace back to R.L. Moore, but which, in our implementation at UAB, includes elements of guided reinvention (Freudenthal, Gravemejier). In this talk I will describe the implementation of the course at UAB, the reaction of students to the course, and the implications for the future of the course at UAB. In this endeavor, I have been ably assisted by William Bond, a former mathematics MS student of mine, and David Cosper, a current BS/MS Fast-Track mathematics student at UAB.

Vilma Mesa and Tim Whittemore, University of Michigan

Concerns About Teaching Mathematics with IBL Methods

In this presentation, we report on our ongoing investigation into the concerns and challenges instructors report facing as they implement inquiry-based learning [IBL] methods in undergraduate mathematics courses. This study is part of a larger project that seeks to fill a gap in our knowledge about how mathematics faculty members new to teaching with IBL methods learn to use the method. For the last year, we have worked with a sample of 37 IBL instructors teaching at colleges and universities across the country. Using an online survey service, these instructors complete bi-weekly logs to report about the mathematics they are teaching, any concerns they have experienced about teaching, and their general reflections about the IBL method. We have worked to qualitatively analyze their responses and have identified a wide range of concerns instructors report experiencing. While some of these concerns address aspects not unique to IBL courses (e.g., concerns about students' understanding or motivation), other address concerns that are particular to the IBL method (e.g., concerns about covering the necessary material, concerns about lecturing, concerns about facilitating class discussions). Instructors often include solutions they have found to their concerns, information on their use of resources (e.g., colleagues, course materials), and how these solutions and resources benefit their teaching.

Identifying the concerns instructors face and any solutions they may find to resolve these concerns can be useful to new instructors as well as to anyone working to support IBL instructors through mentoring programs and faculty development workshops. Future work includes collecting a

new wave of data and analyzing how instructors' concerns change over time as they gain familiarity with IBL methods.

Elwood Parker, Guilford College

"IBL . . . without a mathematician in sight"

Abstract: When leading a workshop on IBL involving faculty being introduced to Inquiry-Based Learning for the first time and none of whom are mathematicians, what does one do? This report is on the preparation for and conduction of such a workshop. Each of the two workshop sessions was done in IBL-style. In the first session, questions involving teaching any course—regardless of pedagogical style to be used—were posed, responses solicited, with ensuing conversation. The focus was to highlight differences in answers to those questions for IBL approaches and other teaching styles. This report focuses on several questions that elicited the most active conversations, including the process vs. content question, the role of the teacher question, the expectations of the student question, and the use of course materials question. The second session consisted of actual inquiries used in non-math (exception: elementary statistics) courses gleaned from personal experiences in inter- and cross-disciplinary courses and those of colleagues in other disciplines. In this report, several of the examples used are shared.

Dylan Retsek, Cal Poly, San Luis Obispo

Chop Wood, Carry Water, Use Definitions

Abstract: In the spring of 2011, I made my first headlong foray into IBL. The course was Methods of Proof, which is our bridge course from lower-division, computational mathematics to upper-division, theoretical mathematics. In this talk I will describe the evolution of my experience, from inception and development through implementation and results. In the end, qualitative and quantitative data indicate that the IBL version of this course was superior to my past more traditional offerings of the same course.

Rachel Schwell, Central Connecticut State University

Modified Moore Method in Discrete Math

Abstract: For two semesters, I have taught Discrete Math (which serves our computer science majors and strong elementary education students, and functions as our department's transition-to-upper-level-mathematics course) using a modified Moore Method. The students spend half of each 100-minute period presenting problems at the board, and the other half working in groups on the notes (and problems within) that are written by me. Though I do not have enough data at this point to draw any statistics-based conclusions about the success of this method, anecdotal evidence suggests that the students who successfully completed the course did so with a stronger understanding of the basic concepts than their counterparts from standard lecture courses, in addition to gaining an increased sense of independent learning.

Annie Selden and John Selden, New Mexico State University

Mathematical and Non-Mathematical University Students' Proving Difficulties

Abstract: This paper discusses university students' mathematical and non-mathematical proving difficulties. A total of forty-one difficulties have been observed and organized into nine categories. Of these difficulties, twenty-seven are briefly described below. These observations come from several years of teaching an experimental proving course to beginning graduate and advanced undergraduate mathematics students and from teaching an experimental voluntary proving supplement to an undergraduate real analysis course. We believe that discussing and categorizing these difficulties will lead to a greater understanding of students' thinking with regard to proof and to future research.

Robert W. Vallin, Slippery Rock University

Presentation Fridays in Advanced Calculus

Abstract: In Spring 2011, a medical situation resulted in my taking over our year-long Advanced Calculus course mid-year. Since the students already possessed a book for the course, it seemed unfair/unrealistic to suddenly go bookless and switch to full Moore-type notes. Instead, on Monday and Wednesday, there was lecture, with Fridays becoming "Presentation Fridays," where students presented solutions to problems given to them previously. These problems consisted of statements that may or may not be true along with requests for examples. Instead of repeating what was in the book, these problems were extensions of topics, delving into real analysis and topology. This talk will discuss how class was run, including samples of various questions and student reactions.

Violeta Vasilevska, Utah Valley University

Active learning strategies

Abstract: In this talk, I will discuss what worked/did not work in implementing IBL in my Abstract Algebra and Topology classes, and how the different class structures affected the implementation of this method.

In addition, I will discuss various active learning strategies (modification from IBL) that I have frequently used in my classes and have been proved successful.