Inquiry-Based Learning Forum
19th Annual Legacy of R. L. Moore Conference

Expanding IBL Throughout Higher Ed

MathFest at Columbus, Ohio
6:50 PM to 7:30 PM, August 4, 2016
Union Station Ballroom A - GCC

POSTER SESSION

ABSTRACTS

Capaldi, Mindy
Valparaiso University

Teaching Probability through Board Games

"What is the probability of choosing a green ball from an urn with three blue balls, five green balls, and seven yellow balls?" Many students not only struggle to engage with this sort of question but are left wondering why the math world is obsessed with balls and urns. Understanding probability is an important part of quantitative literacy since it is prevalent in everyday life. I demonstrate how to use the board games Carcassonne and Chutes and Ladders as a path for students to learn about probability and Markov chains through a more interesting context.

Cho, Hoyun
Capital University

Flipping Class: Multidimensional Teaching

The "flipped" or "inverted" classroom, in which students study lecture-type material at home and do their "homework" in the classroom, has been the subject of research, particularly in the area of student achievement. Yet Bishop and Verleger (2013) state the need for an underlying theory to the practice. The purpose of this paper is to explore "multidimensional teaching," the authors' extension of the two-dimensional "flipped" classroom concept in light of Cambourne's (1995) Conditions for Learning. One author's math class for pre-service teachers was taught in two styles, a more traditional lecture format and in the "inverted" format. Students in the "flipped" format achieved at a higher level. Moreover, students' open-ended comments reveal that Cambourne's Conditions for Learning were implicit to the teaching practice. The authors suggest that practitioners of this style of teaching should deliberately develop student centered practices, such as those mentioned by Cambourne, in order to retain the power that this teaching style currently has.

Clark, David
SUNY New Paltz

The Teaching of Geometry

Euclid's geometry of around 300BC offered the first axiomatic system, which had a profound impact on western thought for over 2 millennia. But Euclid's system was not mathematically complete because of the limited mathematical knowledge of the time.
Hilbert drew on 19th century mathematics to at last formulate in 1899 a mathematically complete version of axiomatic geometry. But Hilbert's version of geometry was too lengthy and abstract to be used in our schools.
In the 20th century Moore enhanced Hilbert's axiomatic system by engaging students in it rather than just demonstrating it for them. His pedagogy led to the modern shift in Inquiry-Based Learning.
In 1932 Birkhoff simplified Hilbert's geometry by incorporating the real number continuum, providing a mathematically complete system that has replaced Euclid in our school since its introduction with New Math around 1980. But Birkhoff's version succeeded at the cost of abandoning the axiomatic method, the original reason for teaching geometry.
I will present here a new version of geometry, published jointly by the AMS and MSRI that offers the benefits of all four: an axiomatic development, mathematical completeness, inquiry-based learning and teachability in our schools.

Clarkson, Corrin
Indiana University

Helping Students See the Big Picture

In an IBL class students dig deep into the underpinnings of a topic and carefully work out the details for themselves. This is important work, but it is also important that students step back and view the big picture. In an Intro to Proof class, the big picture becomes even more important. The focus of the course is not individual results, but rather the methods of argument that are used in the poofs. Moreover, the students are also learning standards of mathematical writing and are further developing their problem solving techniques. In the Spring 2016 semester, I created a series of written exercises to help my Intro to Proof students reflect on these important aspects of the course. My poster is an overview of those assignments and summary of the outcomes.

Dorée, Suzanne
Augsburg College

Making Discrete Inquiries: An IBL Approach to Discrete Mathematics

Mathematical inquiry is at the core of what mathematicians do – it is our research experiment, our way of thinking through abstract questions, and prelude to developing a theory. Teaching the skills of inquiry helps students grow their inner mathematicians, preparing them for advanced courses and undergraduate research. But the benefits extend beyond. For example, teaching students to pose and test conjectures motivates students to write proofs, improves students' reasoning and writing skills, and builds student confidence. Plus, it is fun and leaves students wanting more. The MAA CUPM Curriculum Guide 2015 agrees: ``[Mathematics] programs should include activities designed to promote students' progress in learning to . . . assess the correctness of solutions, create and explore examples, carry out mathematical experiments, and devise and test conjectures. . . . Students should develop mathematical independence and experience open-ended inquiry.'' (Cognitive Recommendations 1 & 4). How do we teach these skills? Discrete mathematics and inquiry-based learning provides a natural setting. To me this is an ideal content pedagogy pair for teaching mathematical inquiry. For the past seventeen years I have been teaching a sophomore level discrete mathematics course using inquiry-based methods – a little more each time I teach the course. This poster will briefly describe the practical elements of the IBL course structure and highlight a few mathematical activities that have been particularly effective in teaching conjecturing skills. Many of these materials are available for in-class testing at other institutions. Our results couldn't be better – students love the course, they spend a lot of time working on classwork in and out of class, they are prepared for advanced proof courses, and we have increased the number of students going on in mathematics. This work was supported in part by an AIBL Small Grant, Category 1 Fall 2015 cohort.

Hsieh, John
Iowa State University

Modified Moore Method for an Undergraduate Bioinformatics Survey Course

The Moore Method was originally developed by R.L. Moore to teach advanced mathematics in the college setting. There have been many adaptations of the Moore Method, under the broad term Modified Moore Method (M3), which are now classified as a variant of inquiry based learning (IBL). Despite the growing popularity of M3, it is rarely applied beyond mathematics. At Iowa State University, we designed and taught an "Introduction to Bioinformatics" survey course using M3 for the first time during Fall semester 2015. The class size was small (n=12), and students all had a background in the natural sciences, most in the biological sciences. Students had little to no formal training in computational sciences. During the 16-week course, students learned to: 1) work on a remote Linux server, 2) read and write Python code, 3) tackle classic bioinformatics problems, and 4) solve current bioinformatics problems with available tools. As with all M3 courses, learning objectives were met through carefully designed questions given to students prior to each class session. Class sessions were completely led by students (i.e., reversed classroom) presenting solution to the assigned questions. The application of M3 to our course has led to several desirable student outcomes: 1) engagement and ownership of the course material, 2) development of a strong sense of community, and 3) uniform learning outcomes. One of the difficulties we experienced with applying M3 was the creation of the course material. It was tough to create questions that were challenging enough without overwhelming the students.

Jensen-Vallin, Jacqueline
Lamar University

Moore Method Apprenticeship Program at Lamar University

Concurrent with a four-semester Master's program in mathematics, the Moore Method Apprenticeship Program (M2AP) at Lamar University trains students interested in IBL instruction through coordinated mentoring. During their first semester, students observe and assist in an IBL classroom, then teach one class per week during the second semester. Roles are reversed in the third semester (with the student teaching while the faculty assists). In their final semester, students are fully responsible for an IBL class. While this program has a focus on training students to be good and effective teachers, M2AP students also meet all of the standard MS requirements, including writing a thesis. We will highlight our program (for your interested students) and provide details (if you would like to begin a similar program at your institution).

Katz, Brian
Augustana College

Describing Mathematical Inquiry

The scientific method is often represented visually: while this representation is necessarily a partial summary, it functions as a powerful mnemonic that allows both students and researchers to consider science as a process made up of subcomponent skills and habits. This poster will contain a candidate visual mnemonic for the moves of mathematical this visual description of mathematical inquiry to established ideas about the teaching, learning, and doing of mathematics from the IBL and RUME communities.

Khasawneh, Elaina
Chicago State University

The Effect of Inquiry-Based Learning on Students' Achievement in College Algebra

The importance of mathematics cannot be emphasized enough. The National Curriculum for Mathematics (2009) summarizes the importance of math this way: Mathematical thinking is important for all members of a modern society as a habit of mind for its use in the workplace, business and finance; and for personal decision-making. Mathematics is fundamental to national prosperity in providing tools for understanding science, engineering, technology and economics. It is essential in public decision-making and for participation in the knowledge economy. Mathematics equips pupils with uniquely powerful ways to describe, analyze and change the world. It can stimulate moments of pleasure and wonder for all pupils when they solve a problem for the first time, discover a more elegant solution, or notice hidden connections. Pupils who are functional in mathematics and financially capable are able to think independently in applied and abstract ways, and can reason, solve problems and assess risk. Mathematics is a creative discipline. The language of mathematics is international. The subject transcends cultural boundaries and its importance is universally recognized. Mathematics has developed over time as a means of solving problems and also for its own sake. The effectiveness of any mathematics pedagogy should be examine .If students don't perform well, then the instructional pedagogy used should be changed or modified and if students do well, then the use of the instructional pedagogy should be encouraged by instructors and administrators. This study examined whether the IBL pedagogy has effects on students' math achievement scores in a college algebra class located at a midsized, Midwestern urban university that is classified as a Predominantly Black Institution (PBI).

The study was a quasi-experiment with pre-test and post-test. The sample was 41 students were chosen by a convenience sample. Quantitative analyses were used to determine the effect of the instructional pedagogy on math achievement test score. Analysis of covariance (ANCOVA) was used to analyze data. The findings showed that there was a statistically significant difference in mean math achievement post-test scores between the IBL and the TL groups when controlling for the pre-test.The results of the current study may provide educators with increased insight on how to create an IBL environment and incorporate IBL instruction into the curriculum, which may help students to develop deep understanding, increase the passing rate of students enrolled in college algebra, and reduce the withdrawal rate. The current study may provide evidence that may be beneficial to policy makers and instructional designers who want to design learning environments that foster students' mathematical abilities.

King, Jeffrey
University of Northern Colorado

Students' Social Adaptation to Mathematical Tasks

This qualitative study describes mathematics majors socially adapting to perform mathematical tasks. An advanced undergraduate geometry class taught in an inquiry-based learning setting was observed for social and sociomathematical norms. Three pairs of students engaged in three task-based, semi-structured interviews: paired, individually, then paired again, solving the Seven Bridges of Königsberg and related tasks. A fourth stimulated-recall interview was performed using episodes from the last paired interview. Classroom observations and interview discourses were open coded for themes and coded for structure and function to analyze the norms developed within the classroom and by each pair as shaped by their social interactions. Tentative findings include: 1) aspects of classroom norms transferring to interview settings, 2) use of varying metaphors across social contexts, 3) reliance on empirical strategies rather than structural reasoning, and 4) varying uses of conjectures. In this poster session, evidence from collected data will be shared and how these results could help inform IBL teaching methods will be discussed.

Mahavier, William "Ted"
Lamar University

Journal of Inquiry-Based Learning in Mathematics

The Journal of Inquiry-Based Learning in Mathematics (JIBLM) publishes university-level course notes that are freely downloadable, professionally refereed, classroom-tested, and constitute a full course. JIBLM course notes are intended for instructors to use as notes for their course, for instructors to modify to suit the needs of their students, and for students to use to study a topic independently. Please consider submitting your classroom-tested notes or just visit to chat about your notes. We are always soliciting submissions.

Martin, Erin
Westminister-College

IBL Advanced Calculus: Using Peer-Review as a Capstone Experience in Mathematics

We will present the results of a case study on the use of full-IBL techniques rooted in the notion of "peer-review" on the teaching of Advanced Calculus as a capstone experience in mathematics. All students were mathematics majors but almost all planned to pursue careers in other fields such as economics, physics, engineering, or education. This presentation will provide practical methods for designing course structure, lesson plans, and daily activities as well as concrete strategies for creating student "buy-in", developing student confidence, and overcoming unforeseen challenges. The success of techniques will be demonstrated through anonymous mid-semester evaluations and end-of- semester IDEA survey results. Funding for the first semester of this research was provided by an Academy of Inquiry-Based Learning Small Grant.

Paul, Stepan
University of California-Santa Barbara

3D Printing in an IBL Vector Calculus Class

With minimal overhead in terms of cost and necessary expertise, 3D printers have become an affordable commodity to the mathematics educator. I will share experiences using a bottom-of-the-line 3D printer in an inquiry-based vector calculus class. My poster will include specific lessons using 3D printed models about partial derivatives, level sets, and regions in R^3. I will also bring samples of models used in these lessons, as well as student-designed models.

Piercey, Victor
Ferris State University

Scaffolded Writing Activities in an IBL Gen Ed Course for First Year Students

Most first-year students find expressing their mathematical thoughts in writing challenging. I will share a series of writing exercises designed to help students in the coming academic year work their way up to fluidly communicating mathematical concepts in prose.

Richter, Gary
Southwestern University

Numbers and Algebra: Axioms and theorems for the Novice Mathematician

An alternative title could be "Ordered Fields from an Elementary Standpoint." This is a development of the fundamentals of secondary school algebra through a carefully selected and arranged set of axioms, definitions, and theorems. The presentation is as simple as I could make it, while still giving students the opportunity to start building skill at creating their own proofs.

Ross, John
Southwestern University

Experiences Using Group Proof-Writing and LaTeX in an IBL Topology Class

This poster will share the presenter's experiences of teaching an IBL Topology course. In particular, two non-traditional choices were made that greatly affected the course: (1) to let students write proofs in small groups, and to devote a large amount of class time to this collaborative work, and (2) to force students to typeset final drafts of all presented proofs (using LaTeX) outside of class. The poster will detail the reasoning behind these choices, as well as the methods of implementation. The consequences of these choices, both positive and negative, will be also be discussed. Finally, the students' reactions and impressions to these choices (and their overall impressions of the course) will be shared.

Sachs, Bob
George Mason University

Towards Guided Reinvention of the Fundamental Theorems of Calculus

Student reinvention of the Riemann sum of products and the Fundamental Theorem of Calculus makes for an inspiring climax to first-semester calculus. Presented with distance/velocity tasks requiring use of average values on subintervals, students create Riemann sums. Some then go on to formulate the Fundamental Theorem of Calculus in its global (fixed endpoint integral) and then local (moving endpoint and derivative thereof) versions. Ongoing refinements of tasks aim to increase the number of successes and productive misses.

Salerno, Adriana
Bates College

Using Experimentation to Discover Number Theory Concepts

In this poster, we show a few examples of how one can use experimentation to complement an IBL approach to Number Theory. We will also show the benefits of using the Sage Math Cloud and Piazza for class discussion and class management.