

Sabbatical Report

Bill Ardis

The purpose of this sabbatical was to gain expertise in the teaching method known as Inquiry Based Learning (IBL). The sabbatical occurred during the fall semester of 2018. A major part of the sabbatical focused on researching and developing materials for use in class using a particular form of IBL known as the Modified Moore Method (MMM). Using the information gained, and the materials developed as part of this sabbatical, I began implementing this method into the section of MATH 2413 – Calculus I that I am teaching in the spring semester of 2019.

The Academy of Inquiry Based Learning (AIBL) describes IBL as “a broad framework for teaching mathematics that is applicable in a wide range of situations.” The AIBL lists two components of IBL:

1. Student engagement in rich mathematical tasks
2. Regular opportunities for student-to-student and student-to-instructor collaboration.

I started my research into Inquiry Based Learning (IBL) before my sabbatical began. I focused on a particular form of IBL, called the Modified Moore Method. This research included rereading a guide to the Moore Method, as well as reading a biography of R. L. Moore, the creator of the Moore Method. My readings also focused on other forms of IBL, as well as related topics including Blooms taxonomy, best teaching practices for student centered classes, and a discussion on how mathematicians do mathematics.

One interesting anecdote from the R. L. Moore biography gives insight into how Moore developed his method. When Moore was a student at the Dallas Lyceum, his mathematical abilities were beyond those of his teachers. He obtained a copy of the calculus textbook that the University of Texas was using at the time. Working through the textbook, he would attempt to construct the proof of each theorem. If he was unable to start the proof, he would uncover one line and see if he could work out the rest of the proof. If he was unable to get the next step, he would then uncover another line and attempt to complete the proof. He would continue in this manner until he completed the proof. It was important to Moore that he be able to complete the proof without any help. This episode highlights the main focus of Moore’s method, getting students to create mathematics on their own.

In August of 2018, I attended MathFest, the summer meeting of the Mathematical Association of America. MathFest included several sessions on IBL, as well as the minicourse “*Introduction to Inquiry-Based Learning*.” This meeting also gave me an opportunity to meet with my mentor, Dr. Ted Mahavier. Dr. Mahavier gave me advice on developing materials and implementing the Modified Moore Method in a class. He recommended that I should begin by using an existing set of notes that I could modify if necessary. As he put it, “You don’t learn how to sail by first building a boat.” He offered to provide me with the original files for his set of calculus notes. We also discussed quizzes and other turn-in work and he gave me a couple of ideas for my course. I attended the minicourse “*Introduction to Inquiry-Based Learning*,” which was for mathematics faculty interested in developing and offering an IBL class. The minicourse focused on developing student buy-in to an IBL style class and techniques to

engage students in an IBL class. I also attended most the talks that were part of the contributed paper sessions *"Inquiry-Based Learning and Teaching."* These talks provided lots of examples of how IBL is implemented in different mathematics classes (including calculus) as well as ideas for activities in class. One of the other sessions discussed the importance of issues with assessment questions in the context of Bloom's (revised) Taxonomy. During my sabbatical I read up on the revised Bloom's taxonomy, and the information gained has applications not only to any IBL course I will teach, but to all of the courses I teach.

A major part of the sabbatical was spent investigating and developing materials for use in my MATH 2413 – Calculus I class. On the advice that I received from both my mentor as well as the Moore Method guide, I decided to use an existing set of materials (which could be modified) for my initial attempt at teaching an IBL class. The best source for materials is the Journal of Inquiry-Based Learning in Mathematics (www.jiblm.org). This site provided several sets of notes that would be applicable for a calculus sequence. In the end, the set that best suited my needs were those that had been developed by my mentor. Dr. Mahavier shared with me his original LaTeX files. LaTeX is a mathematical typesetting language, and this meant that if I wanted to modify the notes, I would need to learn LaTeX. After a brief investigation of free LaTeX editors, I chose to use the online LaTeX editor Overleaf. I also investigated other sources of possible problems to include in my notes. One good source for material for my notes was found at the GoodQuestions Project website (<http://pi.math.cornell.edu/~GoodQuestions/>). This project provides a good set of questions that can lead to inquiry in various calculus topics.

The development process consisted of working through the notes, which included working all of the exercises, and making any modifications I felt necessary. The reason I worked all exercise was twofold: 1) I wanted to familiarize myself with the order of presentation of the topics, and 2) to determine the intended goal(s) of the problems in each section and make notes for possible discussion. Minor changes were made to the order in which one or two topics were presented. I made these changes so that the material is presented in an order that I believe works well. Also, some of the problems were modified to problems that I felt would do a better job of engaging students with certain mathematical concepts.

Once in the classroom, it is important to explain to students how this new method will differ from a traditional lecture course. Several talks at MathFest suggested using the Dana Ernst activity "Setting the Stage," which is suited for any IBL class. In this first day activity, the students form groups of two to three people and discuss the following questions:

1. What are the goals of a university education?
2. What do you reasonably expect to remember from your courses in twenty years?
3. How does a person learn something new?
4. What is the value of making mistakes in the learning process?
5. How do we create a safe environment where risk taking is encouraged and productive failure is valued?

After about 10-15 minutes, the class is brought together again, and each group reports a summary of their responses to each question. While all questions are aimed at getting buy-in to an IBL approach, the first two questions also provide an opportunity to discuss the core objectives for the course. The core objectives students should develop (and hopefully remember) from our mathematics courses are critical thinking skills, communication skills, and empirical and quantitative skills.

Upon returning to teaching in the spring of 2019, I am teaching a section of MATH 2413 – Calculus I using the information I gained from my sabbatical. Based on a suggestion from the book *The Moore Method*, I have kept a journal during course of the semester. This will be useful source of information to refer back to as I make changes to the course for subsequent semesters. At the end of the semester, I will decide whether I want to modify the set of notes I developed, or should I create my own set of notes. I am scheduled to teach an honors section of MATH 2413 in Fall 2019 and I will continue to use IBL in this class. It is my goal to teach MATH 2414 – Calculus II in Spring 2020 using IBL. My long term goal is to use some form of IBL in all upper level mathematics classes that I teach.

I would like to thank Collin College for offering this opportunity and the Sabbatical Committee for selecting me. Not only did this sabbatical allow me to investigate an alternate pedagogy, it also gave me the chance to examine how I teach. In the course of my research, not only did I learn about IBL, but I was also exposed to some best practices that are applicable to a class using other pedagogies. This sabbatical gave me an opportunity to “recharge my batteries” and I am excited about the possibilities for students as I implement IBL in the courses I teach.

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