



MathILy-Er 2019 Final Report

Preface

This was the fifth year of MathILy-Er. As usual, we had a fantastic group of students who enjoyed being together while doing math, and learning and growing mathematically.

Program Preparations

Promotions:

Emails: Individual emails were sent to promising applicants from 2018 inviting them to apply for 2019. MathILy-Er 2018 participants were emailed as a group notifying them when the EAR became available.

Webpage hits: From September through December 2018, web traffic was a bit under 2000 hits per week; it went up to about 2600 hits per week January through March 2019, up to 3600 in April 2019, then declined down to 1700 by mid-June, where it stayed through August 2019.

Impacts: About 53% of applicants found {MathILy, MathILy-Er} on a summer program list, 34% found {MathILy, MathILy-Er} via a web search, 25% were alerted by a parent or guardian, 20% were informed by a teacher. About 7% of applicants said they heard about {MathILy, MathILy-Er} from a friend (20) or relative (5) who had attended or applied, and of these students, 5 were admitted to MathILy-Er.

Applications:

Statistics: There were 306 completed applications, of which 45 became admitted students. Of the 45 admitted students, 28 chose to attend. Thus, our current yield rate is roughly 62%.

The data in the following table was measured where possible and approximated otherwise.

Percentage	Female	East Asian	South Asian	Latinx	Middle Eastern	Other of color
Short Forms	37%	37%	10%	3%	3%	2%
EARs	35%	39%	12%	3%	1%	2%
Attending	53%	35%	11%	7%	0%	4%

Financial Aid: We were able to award \$12400 in financial aid to MathILy-Er participants (all to domestic students). We met the level of demonstrated need for all admitted students who applied for financial aid.

Personnel

Academic: There were two Lead Instructors (LIs), Dr. Alice Mark (Vanderbilt University, Ph.D. University of Texas at Austin, 2015) and Dr. Jonah Ostroff (University of Washington, Ph.D. Brandeis University 2013). There was one Instructor, Dr. Cathy Hsu (University of Bristol, Ph.D. University of Oregon 2018), teaching only during the third week. There were six graduate Apprentice Instructors (AIs), Emi Brawley (University of California, Davis), Connor Halleck-Dube (Cambridge University), JD House (University of California, Davis), Josh Mundinger (University of Chicago), Rebecca Rohrlach (Brandeis University), and Corrine Yap (Rutgers University).

Administrative: The Director was Dr. Alice Mark. The {MathILy, MathILy-Er} Minion was Madison Stuart (Smith College B.A. 2006 in Mathematics and German; graduate work in information science at the University of Michigan). The Protector and Responder in the MathILy-Er Environment (PRiME) was Sam Wilson (Carson-Newman University).

Advisory Amalgam: These individuals gave advice on academic and practical aspects of MathILy.

[Dr. Douglas J. Shaw](#), mathematics faculty at University of Northern Iowa

[Dr. Ruth Haas](#), mathematics faculty at University of Hawaii

[James Cocoros](#), mathematics faculty at Stuyvesant High School

[Dr. Dylan Shepardson](#), mathematics faculty at Mount Holyoke College

[Dr. Carol E. Fan](#), operations researcher (currently Director of Data Science at [Stellar Labs](#))

[Dan Zaharopol](#), Executive Director of [BEAM](#)

[Dr. James Tanton](#), mathematician, currently Ambassador for the [MAA](#)

[Dr. Joshua Greene](#), mathematics faculty at Boston College

[Dr. Emily Peters](#), mathematics faculty at Loyola University Chicago

[Wing L. Mui](#), mathematics faculty at the [Overlake School](#)

[Dr. Thomas Hull](#), mathematics faculty at Western New England University

[Dr. Josh Laison](#), mathematics faculty at Willamette University

Student Demographics:

States represented by MathILy-Er students, in order from most to least number of students: California, New York, Colorado, Texas, Connecticut, Virginia, Missouri, North Carolina, Illinois, New Jersey, Alaska, Pennsylvania, Massachusetts

Countries outside the US: China

Gender breakdown: 14 female, 13 male, 1 nonbinary

Age: There were four 14-year-olds, five 15-year-olds, one of whom turned 16 during the program, twelve 16-year-olds, and five 17-year-olds.

Academic Background: Seventeen students had taken some Calculus before the start of the program; two had taken some discrete math; two had not yet taken Precalc.

What Happened at MathILy-Er 2019?

Academics

Classes: Each weekday we had 4 hours of morning class, 1 hour of Daily Gather, and 3 hours of evening problem session, for at least 8 contact hours per day (not including mathematical conversations held outside of class). Weekends varied, but Saturdays usually consisted of 4 hours of morning class and 1–2 hours of life seminar.

The basic curricular structure was two weeks of core curriculum, called Root Class (after the Root of a graph theoretic tree, and after the idea that the material strengthens student grounding much as the roots of a tree do), followed by one week of short topical classes, called the Week of Chaos, followed by two weeks of a focused topic, called Branch Class (after branches of mathematics, and after the idea that tree branches grow from a strong trunk nourished by roots).

Root Class: The 28 students were split into two Root classes, each taught by one LI and two AIs. The material in Root Class included matrix algebra and ring theory, enumerative combinatorics, graph theory, and combinatorial game theory. All of this material was treated with full proofs given by the students.

Week of Chaos: Students indicated which of 30 potential topics they would be excited to learn about. Instructors compiled these favorites into a list of fifteen courses. The courses offered were as follows: Hard Problems (algorithms and computability), Hyperplane Arrangements, Cardinal & Ordinal Numbers, Markov Chains, Surfaces, p-adic Numbers, A Tour of Turing, Number Theory, Generating Functions, Methods of Proof, Algebraists Anonymous (groups and rings), Reflection Groups, Forbidden Colorings (Ramsey theory), The Alternating Sign Matrix Conjecture, and Axiom! I Choose you!

Branch Class: There were two Branch classes, on the topics of Combinatorial Game Theory and Non-Euclidean Geometry. Students each took one of these.

Pedagogy: All classes were conducted through inquiry-based learning, with students writing on the board and working in groups throughout most of the morning class.

Feedback: Students received feedback in several ways. Class presentations were often met with feedback from instructors and students, both for mathematical correctness and style. Students received written comments on their problem session work, always on the following day. Near the end of Root and Branch classes, students wrote self-evaluations on their progress at MathILy-Er. Then, individual interviews were held with the students to discuss the content of their self-evaluations and other areas for improvement.

Daily Gather: The instructors each gave at least one Daily Gather. The Daily Gather time slot was occasionally used for other activities, such as math movies or a Sage tutorial. The remaining Daily Gathers were interactive presentations by visiting mathematicians.

The Swap

This year, for the first time, four AIs swapped between MathILy and MathILy-Er. The purposes of the swap were to implement teaching practices from MathILy at MathILy-Er, and to have more communication between the two programs. Overall, we are happy with how the swap went and what we learned.

Extracurriculars

Life Seminars: Three Life Seminars were held on weekend afternoons. Each was a mostly unstructured two-hour period where students could ask the staff about applying and going to college, work as a mathematician, and general practical matters of life and adulthood.

Other program-wide activities: At the end of the first week, students and staff explored a nearby park in Brunswick. At the end of the third week, students and staff took a day trip to Portland. Towards the end of the program, there was an informal talent show.

Non-program-wide activities: Student recreational activities included running, tea time, violin, sidewalk chalk art, and piano. Students often played board games in the lounges.

Administrative Matters

Facilities at Bowdoin: Bowdoin was able to give us dorms and classrooms this year that were better suited to our needs than the ones we were in last year. As before, the dining hall was incredible, the campus was very pretty, and the summer conferences staff was extremely responsive and easy to work with.

Brunswick: Brunswick was a nice quiet town. Students and staff enjoyed the several used bookstores, the bakery, the candy store, and lobster rolls.

Post-Processing

Post-program staff meetings: On Saturday evening after the last student left, the staff who were present met to discuss the summer.

We were happy with a lot of things about the Root curriculum, but we also identified areas where we plan to make changes for 2020.

In terms of cross-pollination, we felt that the swap was a great success. We feel like we learned a lot at MathILy-Er, both in terms of big picture what we should be doing and day-to-day how to make things happen the way they should.

Finances Summary: The income from student fees (some discounted) was \$115,638.

No donations were earmarked for financial aid.

Our Epsilon Grant award was \$4,000.

Total MathILy-Er income: \$119,638.

Administrative expenses (insurance, fliers, etc.) totaled approximately \$1,948.

Total wages (instructors, PRiME, Minion, Director) were approximately \$37,730.

Travel costs (Daily Gather speakers, instructors) were approximately \$3,466.

Program expenses (supplies, program outings) were approximately \$1,431.

Site (Bowdoin College) charges, including housing, meals, and duplications were \$76,933.

Total MathILy-Er expenses: \$121,508.

We were fortunate to receive in-kind donations of volunteer time worth \$1,445.

An externally administered travel grant paid for an additional \$1,507 in travel expenses.

The shortfall of approximately \$1,900 arises from financial aid needs that exceeded program income, despite slightly lower-than-expected site expenses as well as a federally supported instructor.