



MathILy-Er 2020 Final Report

Preface

This was the fifth year of MathILy-Er. Due to COVID-19, MathILy-Er was fully online. We tried give the students as close an experience as possible to the one they would have had in-person. Inevitably, being online influenced every aspect of the program.

Program Preparations

Promotions:

Emails: Individual emails were sent to promising applicants from 2019 inviting them to apply for 2020. MathILy-Er 2019 participants were emailed as a group notifying them when the EAR became available.

Webpage hits: Over the last year (September 2019–August 2020), there were about 108K hits. Very roughly, this was about 8K hits per month in the fall and 10K hits per month in the Spring, similar to the previous year.

Impacts: About 53% of applicants found {MathILy, MathILy-Er} on a summer program list, 31% found {MathILy, MathILy-Er} via a web search, 29% were alerted by a parent or guardian, 13% were informed by a teacher. About 8% of applicants said they heard about {MathILy, MathILy-Er} from a friend (27) or relative (4) who had attended or applied, and of these students, 2 were admitted to MathILy-Er.

Applications:

Statistics: There were 396 completed applications, of which 41 became admitted students. Of the 41 admitted students, 27 chose to attend. Thus, our current yield rate is roughly 65%.

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%	35%	23%	2%	4%	2%
EARs	31%	42%	21%	2%	1%	1%
Attending	48%	55%	11%	0%	3%	0%

Financial Aid: We were able to award \$950 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 three Lead Instructors (LIs), Dr. Alice Mark (Vanderbilt University, Ph.D. University of Texas at Austin, 2015) , Dr. Jonah Ostroff (University of Washington, Ph.D. Brandeis University 2013) and Dr. Nate Harman (IAS, Ph.D. MIT 2017). There were five Apprentice Instructors (AIs), Annie Meyers (M.S. University of Wisconsin, Milwaukee, 2013, Adult and Continuing Education; M.S. University of Iowa 2007, Mathematics), Corrine Yap (Rutgers University), Connor Halleck-Dube (University of California, Berkeley), Dylan Cordaro (University of Michigan), and Henry Hale (University of Chicago).

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 (University of Tennessee, Knoxville).

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

[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](#), Seattle-area artist and mathematics teacher

[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: New Jersey, California, Illinois, Massachusetts, Connecticut, New York, Pennsylvania, Missouri, North Carolina, Delaware, Texas, Virginia, Indiana.

Countries outside the US: China, South Korea, Singapore.

Gender breakdown: 13 female, 13 male, 1 nonbinary.

Age: There were six 14-year-olds, nine 15-year-olds, seven 16-year-olds, and five 17-year-olds.

Academic Background: 14 students had taken some Calculus before the start of the program; 1 had taken some Linear Algebra; 5 had not yet taken Precalc.

What Happened at MathILy-Er 2020?

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. This does not include mathematical conversations held outside of class, though being online meant there were fewer such conversations than usual. Weekends varied, but Saturdays usually consisted of 4 hours of morning class and 1–2 hours of life seminar. Classes met on Zoom, and students collaborated using Google Docs and the shared whiteboard tool Limnu.

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 27 students were split into two Root classes, each taught by one LI and two AIs. The material in Root Class included linear algebra over \mathbb{F}_2 , 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 31 potential topics they would be excited to learn about. Instructors compiled these favorites into a list of eighteen courses. The courses offered were as follows: Knot Your Average Theory, Number Theory is Just a Theory, Hyperplane Arrangements, Cardinal & Ordinal Numbers, Markov Chains, Cryptography, The Cantor Set, Surreal Numbers: A Play in Five Acts, Surfaces-Level Understanding, p -adic Numbers, A Tour of Turing, Obviously Great Functions and Exceedingly Glorious Functions (Generating Functions), Methods of Proof, A Tale of n Cities (enumerative graph theory), Block Design and Latin Squares, Epidemic Math, Erdős Magic, and Incompleteness of Arithmetic.

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

Pedagogy: All classes were conducted through inquiry-based learning, with students writing and drawing on Limnu and Google Docs, and working in Zoom breakout 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 Gathers: The instructors each gave at least one Daily Gather. The Daily Gather time slot was occasionally used for showing math movies. The remaining Daily Gathers were interactive presentations by guest mathematicians.

Legacy of the Swap

In 2019, 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. This year we continued with many of the changes that were made, and four MathILy-Er instructors had prior experience at MathILy.

Extracurriculars

Life Seminars: Life Seminars were held on three Saturdays. 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: All students spent the lunch hour together on Zoom during the first week, and several continued to do so for the duration of the program. Towards the end of the program, there was an informal talent show.

Non-program-wide activities: Student recreational activities included a variety of online puzzle and escape games. Some games also happened asynchronously over Slack.

Administrative Matters

Online tools: We used Zoom for all meetings, Limnu as a shared whiteboard, Google Docs as a shared writing space, Google Classroom for collecting and commenting student work, Google Drive for distributing and sharing files, and Slack as a communications center.

Post-Processing

Post-program staff meetings: The post-program meeting was split over two sessions, one on the Saturday afternoon immediately after the program ended and the other on the following Monday evening.

We were happy with the changes that were made to the Root curriculum, and have a plan for further revisions.

We agreed that having the program online was better than not having it at all, and we would do it online again if we have to.

Finances Summary: The income from student fees (some discounted) was \$56,025.

No donations were earmarked for financial aid.

Our Epsilon Grant award was \$3,000.

Total MathILy-Er income: \$59,025.

Administrative expenses (insurance, fliers, etc.) totaled approximately \$1,217.

Total wages (instructors, PRiME, Minion, Director) were approximately \$37,620.
Program expenses (supplies, food stipends, postal fees) were approximately \$2,210.
Total MathILy-Er expenses: \$41,047.

The net revenue of approximately \$17,978 arose from more students participating in the program than feared, along with lower than expected financial aid needs. We expect that when we return to in-person operations, there will be significant financial aid need because of the economic effects of the global pandemic, and this revenue will be applied toward that need.

Because we did not have on-site expenses, we were able to have final numbers earlier than usual; these numbers were calculated October 2019–August 2020.