



## MathILy-Er 2023 Final Report

### Preface

This was the ninth year of MathILy-Er. We were once again very happy to be able to have the program so close to MathILy.

### Program Preparations

#### Promotions:

*Emails:* Individual emails were sent to promising applicants from 2022 inviting them to apply for 2023. {MathILy, MathILy-Er} 2022 participants were emailed as two groups notifying them when the EAR became available.

*Webpage hits:* Over the year we had 127,000 hits, with a per-month low of about 6,500 in August 2022 steadily increasing through the fall, and maintaining at about 15,000/month during January–April 2023. The MathILy-Er home page accounts for about 3.5% of webpage hits, with the applications page at 13.5%.

*Impacts:* 57% of applicants found {MathILy, MathILy-Er} on a summer program list, 28% found {MathILy, MathILy-Er} via a web search, 25% were alerted by a parent or guardian, 17% were informed by a teacher, 7% applied in a previous year, 13% heard of it from an alumn, and 1% found or were handed a {MathILy, MathILy-Er} flier. About 4% of applicants said they heard about {MathILy, MathILy-Er} from a friend or relative who had attended or applied, and of these students, 3 were admitted to MathILy and 2 were admitted to MathILy-Er.

#### Applications:

*Statistics:* There were 550 completed applications. Of these, 43 were admitted to MathILy-Er. Of the 43 admitted students, 31 chose to attend. Thus, our current yield rate is roughly 72%.

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

Percentage	Female	NB/trans	East Asian	South Asian	Latinx	Middle Eastern	Black and Indigenous
Short Forms	33%	1%	42%	24%	5%	9%	1%
EARs	33%	2%	57%	15%	3%	3%	1%
Attending	58%	0%	52%	3%	10%	0%	0%

*Financial Aid:* We awarded \$18,350 in financial aid to MathILy-Er participants (\$9,975 to domestic students and \$3,650 to an international student). A greater fraction of admitted students applied for financial aid this year (29% vs. 12% last year).

## Personnel

*Academic:* There were two Lead Instructors (LIs), Dr. Alice Mark (Senior Lecturer at Vanderbilt University, Ph.D. University of Texas at Austin, 2015), and Dr. Corrine Yap (Postdoc at Georgia Tech, Ph.D. Rutgers University, 2023). There were two Instructors, Tom Mainiero (Assistant Professor of Math and CS at St. Joseph's University of New York, Ph.D. University of Texas at Austin, 2015, Physics), and Cathy Hsu (Assistant Professor in Mathematics at Swarthmore College, Ph.D. University of Oregon, 2018), teaching only during the third week. There were five Apprentice Instructors (AIs), Kimball Strong (graduate student at Cornell University), Gabe Udell (graduate student at Cornell University), Max Everett (some graduate work in Math at the CUNY Graduate Center, beginning masters student in Education at Hunter College), Natasha Ter-Saakov (graduate student at Rutgers University), and Thea Rugg (beginning graduate student at Cornell 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, Facilitator of Academics and CriTiquer of wRiting (PRiME FACToRs) were Cam Gavalier (beginning graduate student at the CUNY Graduate Center) and Kat Khiev (B.S. in Mathematics Education 2022, student teacher).

*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 (retired)

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

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

[Dr. Carol E. Fan](#), operations researcher (currently Operations Data Science Lead at Apple)

[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 Franklin & Marshall College

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

## Student Demographics:

*States (and district) represented by MathILy-Er students, in order from most to least number of students:* California, New Jersey, Illinois, Minnesota, New York, Pennsylvania, Washington, Alabama, Texas, Maine, Michigan, North Carolina, and Washington DC.

*Countries outside the US:* Canada, Germany, Nicaragua.

*Gender breakdown:* 18 female, 13 male.

*Age:* There were ten 14-year-olds, eleven 15-year-olds, six 16-year-olds, and four 17-year-olds. Four student birthdays fell during the program.

*Academic Background:* 10 students had taken some Calculus before the start of the program; 1 had taken some Linear Algebra; 6 had not yet taken Precalc.

## What Happened at MathILy-Er 2022?

### 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. Weekends varied, but Saturdays usually consisted of 4 hours of morning class and between 1 and 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 31 students were split into two root classes, each taught by an LI and an AIs. The PRiME FACToRs each assisted in one of the classes. The material in Root Class included Farey and Stern-Brocot sequences, linear algebra over  $\mathbf{F}_2$ , enumerative combinatorics, graph theory, combinatorial game theory, and disease modeling. Students also learned and practiced various proof techniques. All the 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: Ayyy, a Fibonacci to You Too (Fibonacci and other recurrences), Becoming brillianter by beckoning bizarre bigness into the brain (Cardinality), Bring Me to Your Leader (Voting), Counting *to the Extreme!* (Extremal graph theory), Dessert Theory (Fair division), From Poof to Proof (Methods of Proof), Knot Another Knot Joke, Magical Matrices (Heisenberg groups), Obviously Great Functions and Exceedingly Glorious Functions (Generating functions), Quick turns (Quaternions), Roundabout Rhonda's Ridiculously Remarkable Ritual (Circle dynamical system), Schwiiiiing! Slassshh! CHOP! Sliiiiiice! (Hyperplane arrangements), Surreal Numbers: A Play in Five Acts, Symmetry (group actions), That Game With 81 Cards (SET), That's Numberwang! (Number Theory), A Whole New Number World (p-adics), and Who's in Charge Here? (Power Indices).

*Branch Class:* During the last two weeks of the program, students took one of two Branch classes. The courses were Discrete Probability and Non-Euclidean Geometry. Students were given the opportunity to indicate which class they preferred, and were placed based on preference. The Geometry class has been taught every year since 2017, but the Probability class was new this year.

*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 and collaboratively working on a problem set and writing up proofs during the evening 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 set work, always on the following day. Near the end of Root and Branch classes, students wrote introspective self-evaluations on their progress at MathILy-Er. Then, individual interviews were held with the students to discuss what they had written, as well as other areas for improvement.

*Daily Gatherers:* The instructors each gave at least one Daily Gather. The Daily Gather time slot was occasionally used for showing math movies. The remaining Daily Gatherers were interactive presentations by guest mathematicians, most of whom were visitors from MathILy.

## **Extracurriculars**

*Life Seminars:* Life Seminars were held on four weekends. Each was a mostly unstructured one- to 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 walked to a park across the road. At the end of the third week, there was a trip to a nearby ice cream shop. Towards the end of the program, there was an informal talent show.

We ordered MathILy-Er t-shirts for everyone. Several students collaborated with the PRiMEs to come up with a design featuring things from Root class and inside jokes.

Each week, students wrote and edited content for the Record of Mathematics. Students wrote summaries of classes and other program happenings as well as fun and silly observational pieces about life at the program, and drew elaborately detailed covers.

*Non-program-wide activities:* Student recreational activities included soccer, volleyball, swimming, and running, as well as a variety of board and card games.

## **Administrative Matters**

*Eastern Campus and Facilities:* The best thing about Eastern was its proximity to Bryn Mawr, and how easy it was for MathILy and MathILy-Er staff to visit each other's programs. The campus itself had some nice features, including its small size, and the classroom facilities.

*Covid-19 Protocols:* All students and staff took rapid tests on arrival. Following that, everyone wore masks everywhere indoors on campus for the first five days of the program. We then all tested again, and subsequently unmasked around each other. The only place on campus where we regularly encountered people from outside our program was the dining hall. There were no positive tests from anyone during the program.

## Post-Processing

*Post-program staff meetings:* The post-processing meeting began on Saturday evening, an hour after the last student was picked up. We met for an hour and a half, took a break to eat dinner, and then continued after dinner until we were done.

This year's new Branch class went well, and there is room for it to grow and incorporate more computation.

Students were highly motivated to improve their proof writing, and the Methods of Proof class during Week of Chaos was very successful.

*Finances Summary:* The income from student fees (some discounted) was \$131,691.

Donations from Jane Street for financial aid and visitor travel were \$18,000.

We received a donation earmarked for financial aid of \$500.

Our Epsilon Grant award was \$3,600.

Total MathILy-Er income: \$153,791.

Administrative expenses (insurance, fliers, etc.) totaled approximately \$3,016.

Total wages (instructors, PRiMEs, Minion, Directors) were approximately \$48,675.

Wage-related administrative costs (payroll taxes, etc.) were \$784.

Travel costs (visitors, instructors) were \$3,748.

Program expenses (supplies) were approximately \$1,988.

Site expenses from Eastern University were \$100,975.

Total MathILy-Er expenses: \$159,186.

The overage of approximately \$5,395 was expected given an increase in expenses without an accompanying increase in fees.