



## MathILy-Er 2021 Final Report

### Preface

This was the seventh year of MathILy-Er. Due to COVID-19, MathILy-Er was online for the second time. We tried to 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 2020 inviting them to apply for 2021. MathILy-Er 2020 participants were emailed as a group notifying them when the EAR became available.

*Webpage hits:* Over the last year (August 2020–August 2021), there were about 106K hits. Very roughly, this was about 6K hits per month in the fall, 10K hits per month in the winter, and 13K hits per month in the spring, then declining month-over-month over the summer, similar to the previous year.

*Impacts:* About 57% of applicants found {MathILy, MathILy-Er} on a summer program list, 37% found {MathILy, MathILy-Er} via a web search, 17% were alerted by a parent or guardian, 15% were informed by a teacher, 6% applied in a previous year, 2% heard of it from an alumn, and 1% found or were handed a {MathILy, MathILy-Er} flier (despite us not sending out fliers this year). About 5% of applicants said they heard about {MathILy, MathILy-Er} from a friend (18) or relative (5) who had attended or applied, and of these students, 5 were admitted to MathILy-Er.

#### Applications:

*Statistics:* There were 378 completed applications. Of these, 45 were admitted to MathILy-Er. Of the 41 admitted students, 29 chose to attend. Thus, our current yield rate is roughly 64%.

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	54%	50%	4%	0%	3%	0%

*Financial Aid:* We were able to award \$1500 in financial aid to MathILy-Er participants (all to international 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 (Senior Lecturer at Vanderbilt University, Ph.D. University of Texas at Austin, 2015), Dr. Jonah Ostroff (Associate Teaching Professor at the University of Washington, Ph.D. Brandeis University 2013), and Dr. Nate Harman (IBL Postdoc at the University of Michigan, Ph.D. MIT 2017). There were five Apprentice Instructors (AIs), Corrine Yap (graduate student at Rutgers University), Sam Wilson (graduate student at the University of Tennessee, Knoxville), Annie Meyers (AoPS instructor, M.S. University of Wisconsin, Milwaukee, 2013, Adult and Continuing Education; M.S. University of Iowa 2007, Mathematics), Max Everett (graduate student at the CUNY Graduate Center), and Josh Mundinger (graduate student at the 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 Margaret Zheng (undergraduate at MIT).

*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 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 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:* Massachusetts, California, New York, Illinois, Pennsylvania, North Carolina, Maryland, Kansas, Washington, Florida, Oregon, Wisconsin, Texas.

*Countries outside the US:* China, Taiwan, England, Italy, Canada.

*Gender breakdown:* 16 female, 13 male.

*Age:* There were two 13-year-olds, seven 14-year-olds, eight 15-year-olds, nine 16-year-olds, and three 17-year-olds. Four student birthdays fell during the program.

*Academic Background:* 12 students had taken some Calculus before the start of the program; 2 had taken some Linear Algebra; 7 had not yet taken Precalc.

# What Happened at MathILy-Er 2021?

## 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 29 students were split into two root classes, each taught by one LI and two AIs. The material in Root Class included linear algebra over  $\mathbf{F}_2$ , enumerative combinatorics, graph theory, combinatorial game theory, and disease modeling. All of this material was treated with full proofs given by the students.

*Week of Chaos:* Students indicated which of 29 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: A Tour of Turing, Advanced Lock Picking (Rubik's cubes), Algebraists Anonymous, Dessert Theory (fair division), Explod-y Kingdoms (chip firing), Fairly Being Unfair (voting), Generating Functions, How Do Numbers (algebraic number fields), How Many Zeros? (algebraic curves), Knot Your Average Theory, Methods of Proof, That Game With 81 Cards (SET), The Arbitrarily Many Hats of Bartholemew Sledbob (hat problems), Through The Looking Glass (reflection groups), and Ugh, Let's Start Over (incompleteness of arithmetic).

*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 and drawing on Limnu, 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 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.

## Extracurriculars

*Life Seminars:* Life Seminars were held on four 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 gather.town during the first week. Towards the middle of the program, there was an informal talent show.

*Non-program-wide activities:* Student recreational activities included a variety of online games, and drawing and posting memes and cartoons 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, Slack as a communications center, and gather.town as a social space for lunch and games.

## Post-Processing

*Post-program staff meetings:* The post-program meeting was split over two sessions on the Monday and Tuesday evenings following the program.

We were happy with the changes that were made to the Root curriculum, especially with the new section on disease modeling.

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 \$57,463.

Our Epsilon Grant award was \$2,520.

Total MathILy-Er income: \$59,983.

Administrative expenses (insurance, fliers, etc.) totaled approximately \$1,174.

Total wages (instructors, PRiME, Minion, Director) were approximately \$33,331.

Program expenses (supplies, food stipends, postal fees) were approximately \$2,176.

Total MathILy-Er expenses: \$36,681.

The net revenue of approximately \$23,302 arose from being unable to hire as many AIs as usual along with far 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 September 2020–August 2021.