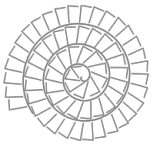

MATHEMATICAL STAIRCASE, INC.

MathILy-EST

MathILy-EST 2025 Final Report

Preface

The MathILy-EST Research Experience for Undergraduates (REU) was created to serve college-age students that are early in their college career (i.e., an emphasis on freshmen, but with consideration for sophomores and even graduating high-school seniors). Also, this REU runs in parallel to the 5-week MathILy program for talented high-school students. Both take place at Bryn Mawr College and all the students and staff share the same dorm building. In 2025, the NSF grant supporting MathILy-EST was not renewed. By using an NSF no-cost extension and supplemental funding from Jane Street, the program was able to support a reduced number of students.

Program Preparations

Promotions

Emails: Notes advertising MathILy-EST were sent to the all-members and IBL MAA Connect lists. The Minion again updated contacts at Historically Black Colleges and Universities and Minority Serving Institutions and Hispanic Association of Colleges and Universities that have mathematics majors or departments, plus Leadership Alliance coordinators, McNair programs and Black and Latinx student centers (focusing on schools with high minority populations for the latter group), and sent emails to these contacts.

Fliers: No MathILy-EST-specific fliers were handed out, though 500 {MathILy, MathILy-Er} fliers that mention MathILy-EST were sent to four high school math contests.

Webpages and links: MathILy-EST has its own webpages, and is listed on the NSF-REU pages (of course) as well as the AMS Opportunities pages, the Institute for Broadening Participation's pathwaystoscience.org, the Math Alliance website, and the Art of Problem Solving's wiki. There are also several online lists of math REUs that include MathILy-EST.

Webpage hits: There were about 12,300 impressions for the mathilyest/index.html page over the 2024–2025 season. The MathILy-EST index page is fourth-most popular on mathily.org at a bit under 6% of visits.

Other Activities: We held a {MathILy, MathILy-Er, MathILy-EST} Yearly Gather at the Joint Mathematics Meetings, where participants team-solved four Jonah-designed nonabelian SET puzzles, the last of which used the solutions to the other three. There were at least 90 participants, and all 13 nine-person tables were populated. In late February sarah-marie offered an Art of Problem Solving Math Jam on REUs in general and MathILy-EST in particular, which was mainly a Q&A. There were about 35 people in the room at most times, and about 190 came/went over the 90 minutes. About 5 non-AoPS guests participated—the ability to attend without making an account is a new feature of the site.

Applications and Admissions

Demographics: There were 116 completed applications for the 4 REU slots. Applicants originated from 32 US states. Some states were over-represented in that number, with at least 20 from MA, 17 from NY, and 13 students from PA schools.

In terms of the demographics during the stages of making decisions, we have the following percentages:

Stage in application	Female	NB/Trans	Asian-American	Black	Latinx	SLAC
All applicants	19%	4%	31%	7%	4%	17%
Long list (20)	35%	0%	5%	10%	20%	20%
Short list (13)	38%	0%	0%	15%	0%	23%
Accepted	50%	0%	0%	25%	0%	0%

All invited students participated in the program.

Personnel:

Academic and Administrative: The MathILy-EST 2025 director was Dr. Joshua Mundinger (Van Vleck Visiting Assistant Professor and NSF Postdoctoral Research Fellow at University of Wisconsin-Madison). The PI on the NSF grant was sarah-marie belcastro (President of Mathematical Staircase, Inc.). The {MathILy, MathILy-Er, MathILy-EST} Minion was Madison Stuart.

Senior Personnel: These individuals gave advice on the construction of MathILy-EST and the NSF proposals for the grants that fund the program.
Hannah Alpert, former mathematics faculty at Auburn University (MathILy-EST director 2020)
Max Engelstein, mathematics faculty at University of Minnesota (MathILy-EST director 2021)
Brian Freidin, mathematics faculty affiliated with Auburn University, teaches at University of San Diego (MathILy-EST director 2023)
Nate Harman, mathematics faculty at University of Georgia (MathILy-EST director 2022)
Thomas Hull, mathematics faculty at Franklin and Marshall College (MathILy-EST director 2019 and 2024)
Emily Peters, mathematics faculty at Loyola University Chicago

What Happened at MathILy-EST 2025?

Academics/Research

The research topic was combinatorial representation theory. The four students worked in one group on the type B version of Armstrong, Reiner, and Rhoades' parking space representatin.

Reading: A week before the program started, the Director sent pairs of students research papers to read that covered background on representation theory of the symmetric group and combinatorial species. Each pair made a Coauthor post summarizing their paper and gave a presentation to the other students on it during the first week.

Mathematical Explorations: The students coalesced around working on one problem: extending the type B parking space. One of the pairs' papers was "Extending the parking space" by Berget and Rhoades. This paper shows that a certain combinatorially defined representation of the nth symmetric group, the *parking space*, extends to a representation of the $(n+1)$st symmetric group. For any Coxeterr group W, Armstrong, Reiner, and Rhoades introduced an analogous representation of W called the W-parking space. These representations are closely linked to parking functions and Catalan combinatorics. When W is the nth hyperoctahedral group B_n, the parking space is the linearization of the natural action of the hyperoctahedral group on $(Z/(2n+1)Z)^n$. The conjecture was that this representation extends to the $(n+1)$st hyperoctahedral group. The students were able to prove a modified version of this conjecture: that the linearization of $(Z/mZ)^n$ extends to a representation of when $m \leq 3$ or when $n \leq 2$. They also used integer linear programming to check the existence of extensions when both $n \leq 7$ and $m \leq 20$.

Professional Development

Writing: The MathILy-EST students each wrote daily on Coauthor to record their ideas, progress, and pitfalls. Every Ever-EST seminar had an official notetaker to write a Coauthor post on the event. In addition, the students were given writing assignments and feedback by the Director. The group prepared a draft of the final paper using Overleaf, with the eventual goal of having it placed on the arXiv and submitted for publication. Participants were also trained on writing CVs and tasked with creating their own professional CVs.

Presentations: The MathILy-EST 2025 program required participants to make many presentations. Every time that MathILy had a visitor to give a Daily Gather, the visitor also met with MathILy-EST, whereupon the students presented their research and work-to-date to the visitor. During the last week of MathILy, the -EST students gave a Daily Gather on their summer research, titled "EST (Easy Sleazy Transportation)." Soon after the program ended, the -EST students had their talk abstract accepted to a Special Session on Algebraic and Geometric Combinatorics at the 2026 Joint Mathematics Meetings in Washington D.C.

Software: Throughout MathILy-EST, the participants used various software packages to aid in their research. They used Sage/Python extensively to experiment on their research problems, as well as LaTeX for typestting.

Other professional development: The Director also provided training to the MathILy-EST students on how to approach research and not get discouraged, giving good math presentations, looking up articles on MathSciNet or other databases, and ethics in mathematics. There was a graduate school panel for the MathILy-EST students that included MathILy AIs and PRiME FACToRs.

Social Activities: The four MathILy-EST 2025 participants formed a tight cohort. Activities included playing board games, going to the gym, and watching the TV show "Love Island".

Administrative Issues

Facilities at Bryn Mawr: The physical environment that Bryn Mawr provided for MathILy-EST was excellent. Two modern "fish bowl" style conference rooms in the atrium area of the Park Sciences building were provided for exclusive use by the REU students. These rooms each had floor-to-ceiling blackboards and a wide-screen TV for projecting computers, and one also had a whiteboard.

Post-Processing

Post-program senior personnel meeting: After the end of the program, there was a meeting to discuss the program and to plan for next year. If the NSF grant is renewed, then David Gonzalez will be the 2026 MathILy-EST Director.

Impact: Students rated all aspects of their MathILy-EST experience as very or somewhat valuable (except for one "not useful" rating of Daily Gather and two "not useful" ratings of MathILy Life Seminar), and all three respondents stated that participation in MathILy-EST has positively influenced their career path or career. The one suggestion for change was to spend more time on initial exercises and approachable problems. Every student visited a MathILy class, and all respondents found it an interesting experience. All respondents reported socializing with MathILy students outside of their classes, and all found it fun and interesting, and most found it valuable. Over 85% of the MathILy students found MathILy-EST somewhat or very valuable to their MathILy experience in general and 63%–82% on each specific aspect queried.

Finances summary:

The income from grant NSF DMS-2149647 was $28,654.45.
The income from Jane Street donations was $17,500.
Total MathILy-EST income: $46,154.45.
Total stipends (director, participants) were $18,900.
Total wages and employee expenses (MathILy director and Minion) were $3665.
Program expenses (t-shirts, markers, SEPTA tickets) were approximately $137.
Site travel expenses for participants and Director were $1,369.
Site expenses from Bryn Mawr are $19,735.
Total MathILy-EST expenses: $43,806.

We were fortunate to receive donations of software from Wolfram Research worth $1540. The difference between income and expenses arises mainly because the above does not include Joint Mathematics Meetings 2026 travel expenses for the 2025 MathILy-EST cohort.