ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #36475

# Diversifying STEM Pathways: Math Circles of Chicago

**Douglas O'Roark, Math Circles of Chicago**

Doug has served as the Executive Director of MC2 since 2915. Previously he led the Secondary Math component of the UChicago Urban Teacher Education Program and was the first teacher hired at Payton College Prep, a school that is regularly ranked as one of the top ten high schools in the country. He was awarded the Radio Shack National Teacher Award, the MAA's Sliffe Award for Distinguished Math Teaching, and the ICTM Rine Secondary Math Teaching Award. Both the City of Chicago Math League and Payton Prep have awards named in his honor.

**Mr. Boz N Bell, HP Inc.**
**Mrs. Tiffany Grant King, HP Inc.**

Mechanical engineer with both academic research experience and industry experience in the areas of automotive, pharmaceutical, paper manufacturing, consumer products/goods, and technology engaged in the challenges in STEM education, talent acquisition, and global business systems.

# DIVERSIFYING STEM PATHWAYS: MATH CIRCLES OF CHICAGO

Doug O' Roark
Boz Bell

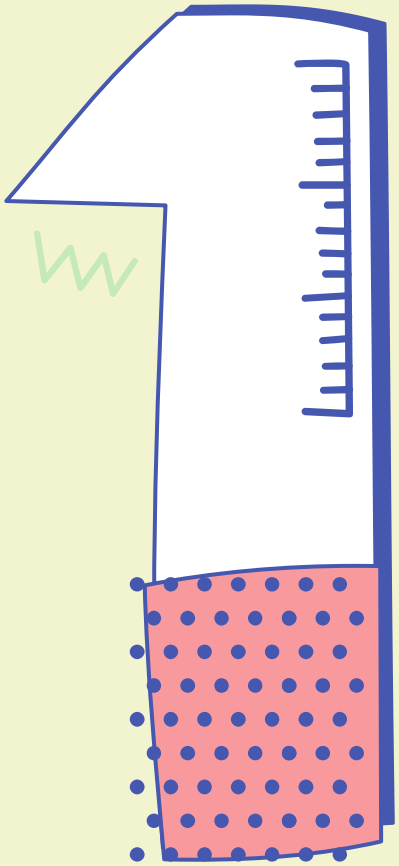
# A New Journey

1. The Need
2. A Solution
3. Outcomes
4. Shared Vision
5. Reflecting on the Journey

# Introductions

Doug O’ Roark

Boz Bell



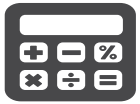
# 01 A Diversifying Pathways: The Need

# Math is Foundational for STEM…and More

MC² MATH CIRCLES OF CHICAGO

***At the University of Illinois, to major in Physics, Engineering, Science or Computer Science you need a collection of skills***

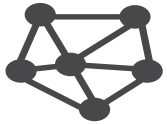
**Calculus**



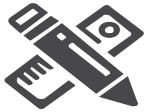
**Multi-Variable Calculus**

**Differential Equations**


**Statistics**



**Discrete Math**



**Advanced Algebra and Pre-Calculus**

***The University of Illinois at Urbana-Champaign is the flagship university of our state and is nationally known for its engineering program***

# Looking at Chicago Today

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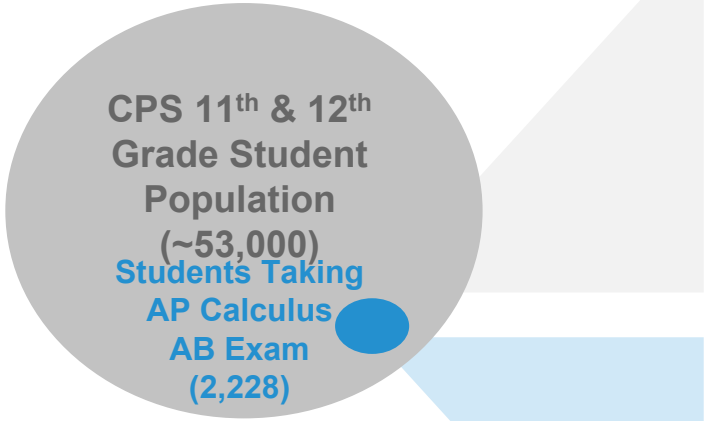
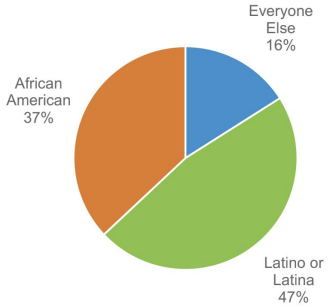
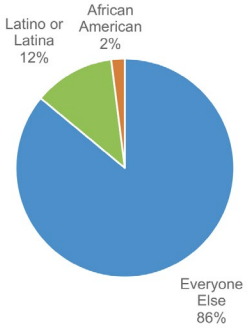



***CPS Students taking AP Calculus are not representative of the overall CPS student population***

**CPS Student Population**




**Students Who Pass the AP Calculus Exam (2017)**




Source: Chicago Public Schools, Department of STEM

# Alternatives to Address the Shortcoming

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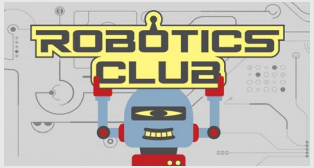
**Pay for Tutoring and Remediation?**

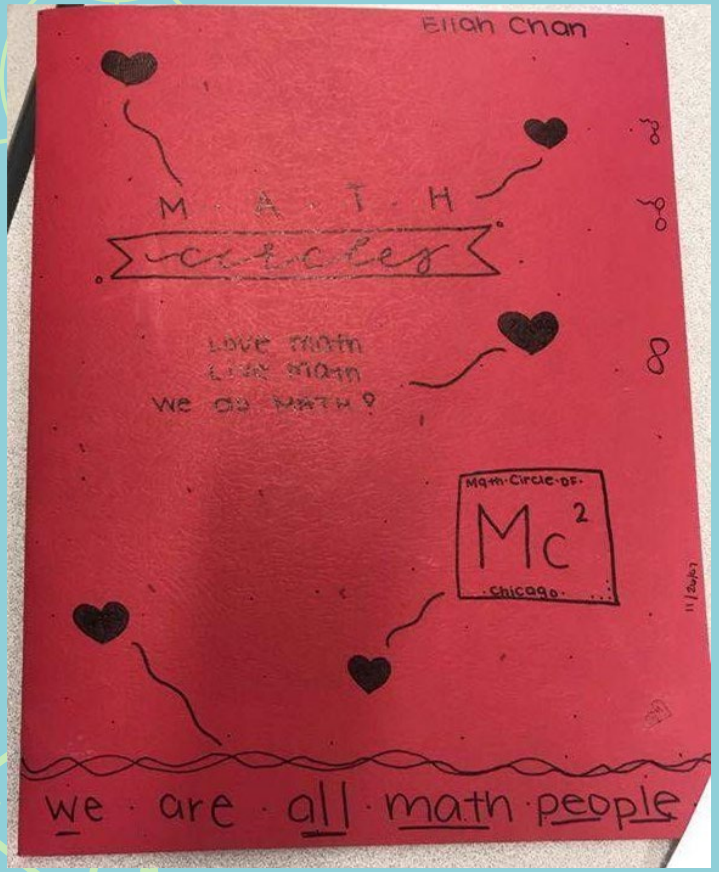
MATHNASIUM
The Math Learning Center

**Enrichment Programs in "STE" but not the "M"?**



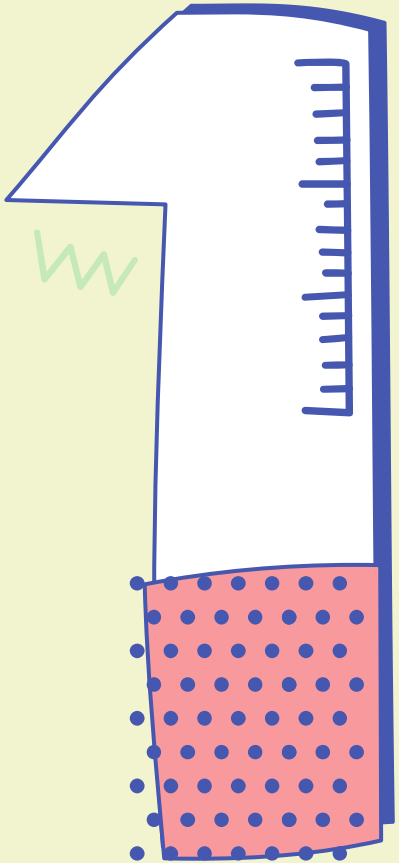

**Math Competitions?**

MATHCOUNTS® COMPETITION SERIES
EST. 1983




## Guiding Questions:

**What are the essential elements of a program that will have real impact in diversifying STEM pathways? How can the engineering community engage in this work?**

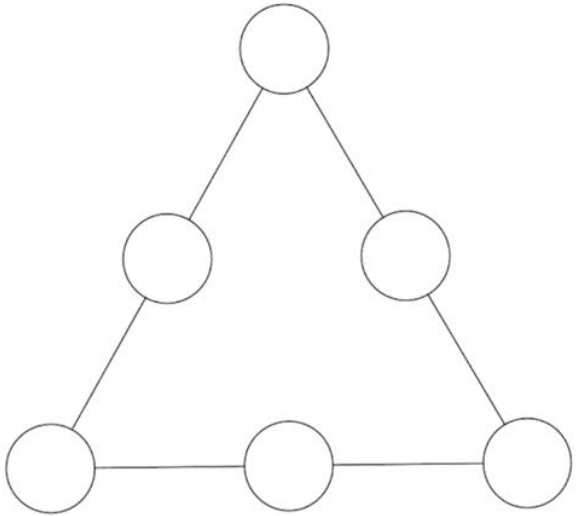


# 01 B

# What is a math circle?

# The Triangle Game: Think/Pair

Place the numbers 1 to 6 in the circles so that the sum along each side is the same.



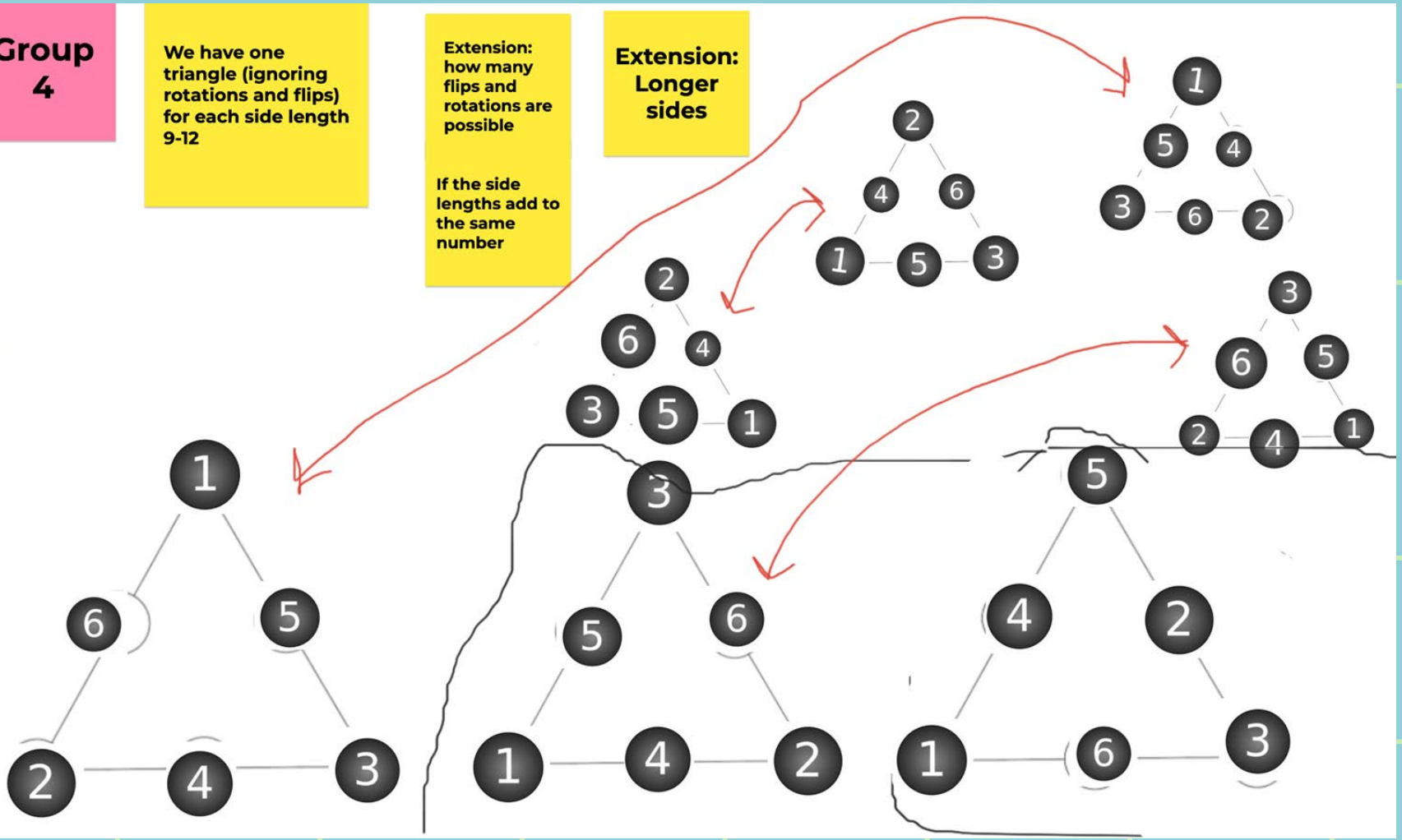
**Group 4**

We have one triangle (ignoring rotations and flips) for each side length 9-12

Extension: how many flips and rotations are possible

If the side lengths add to the same number

**Extension: Longer sides**



# Equipping Kids to Participate in STEM Fields

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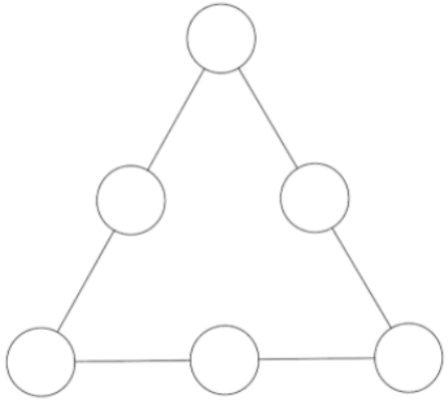
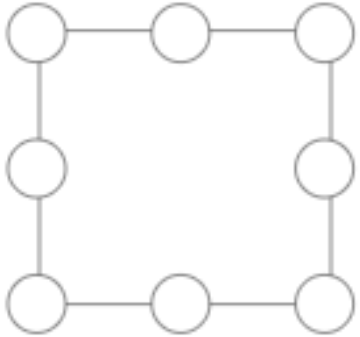
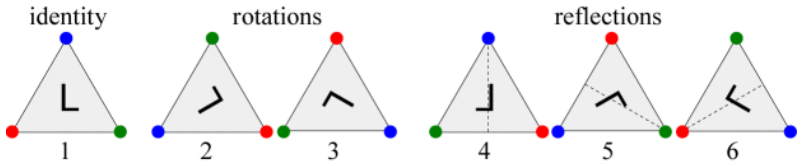
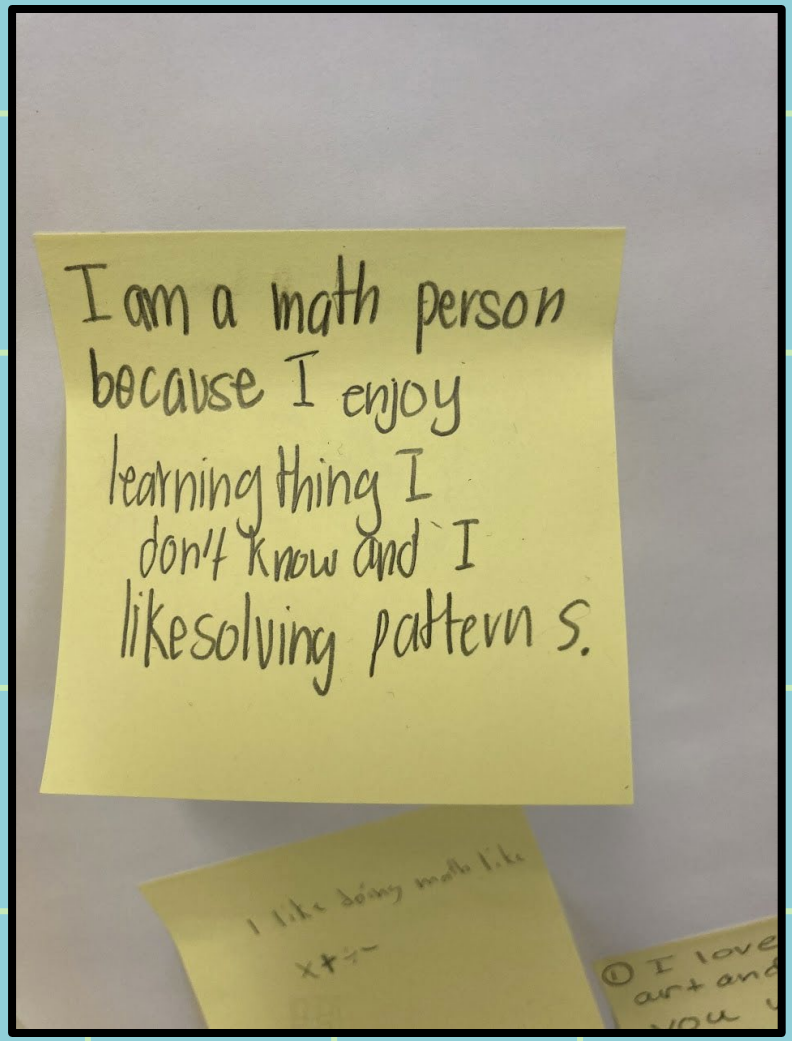
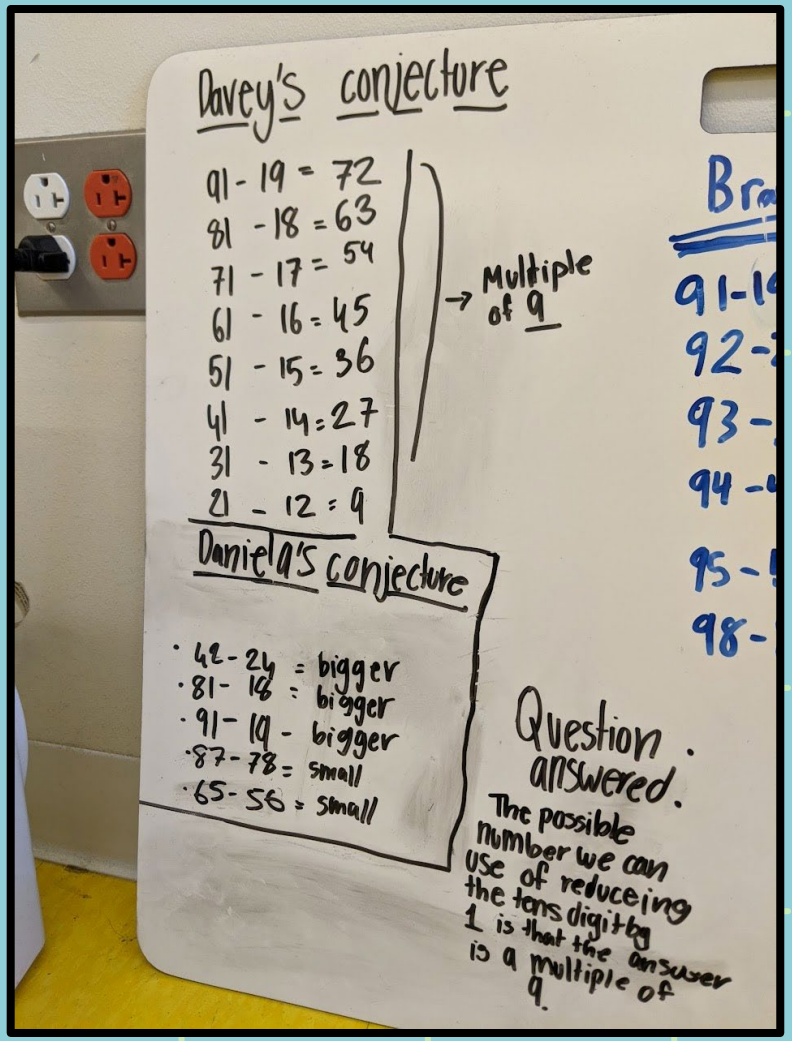




- Symmetry
- Transformational Geometry
- Parity
- Reasoning & Logic
- Algebra/Abstract Algebra/Group Theory
- Extensions & Conjectures




I am a math person because I enjoy learning thing I don't know and I likesolving patterns.


Davey's conjecture
91 - 19 = 72
81 - 18 = 63
71 - 17 = 54
61 - 16 = 45
51 - 15 = 36
41 - 14 = 27
31 - 13 = 18
21 - 12 = 9
→ Multiple of 9
Daniela's conjecture
· 42 - 24 = bigger
· 81 - 18 = bigger
· 91 - 19 = bigger
· 87 - 78 = small
· 65 - 56 = small
Question answered.
The possible number we can use of reduceing the tens digit by 1 is that the answer is a multiple of 9.

How do you know you know you found all of the solutions to the triangle game?

| Strategy | Who and What | Order |
|---|---|---|
| Prove that 8 or 13 is impossible | | 5 |
| Show the 6 symmetries of triangle to argue that some solutions are equivalent | | 4 |
| Argue that given a side sum and one vertex number that numbers in other positions are pre-determined | | 6 |
| Begin by showing that the sum of the vertices must be a multiple of 3 (using Algebra) and arguing from there | | |
| Trial and error/guess and check--includes solutions for 9, 10, 11, and/or 12 | | 1 |
| In effort to give *all* solutions, lists more than 4, some of which are congruent | | 3 |

# 02

# What are the Math Circles of Chicago?

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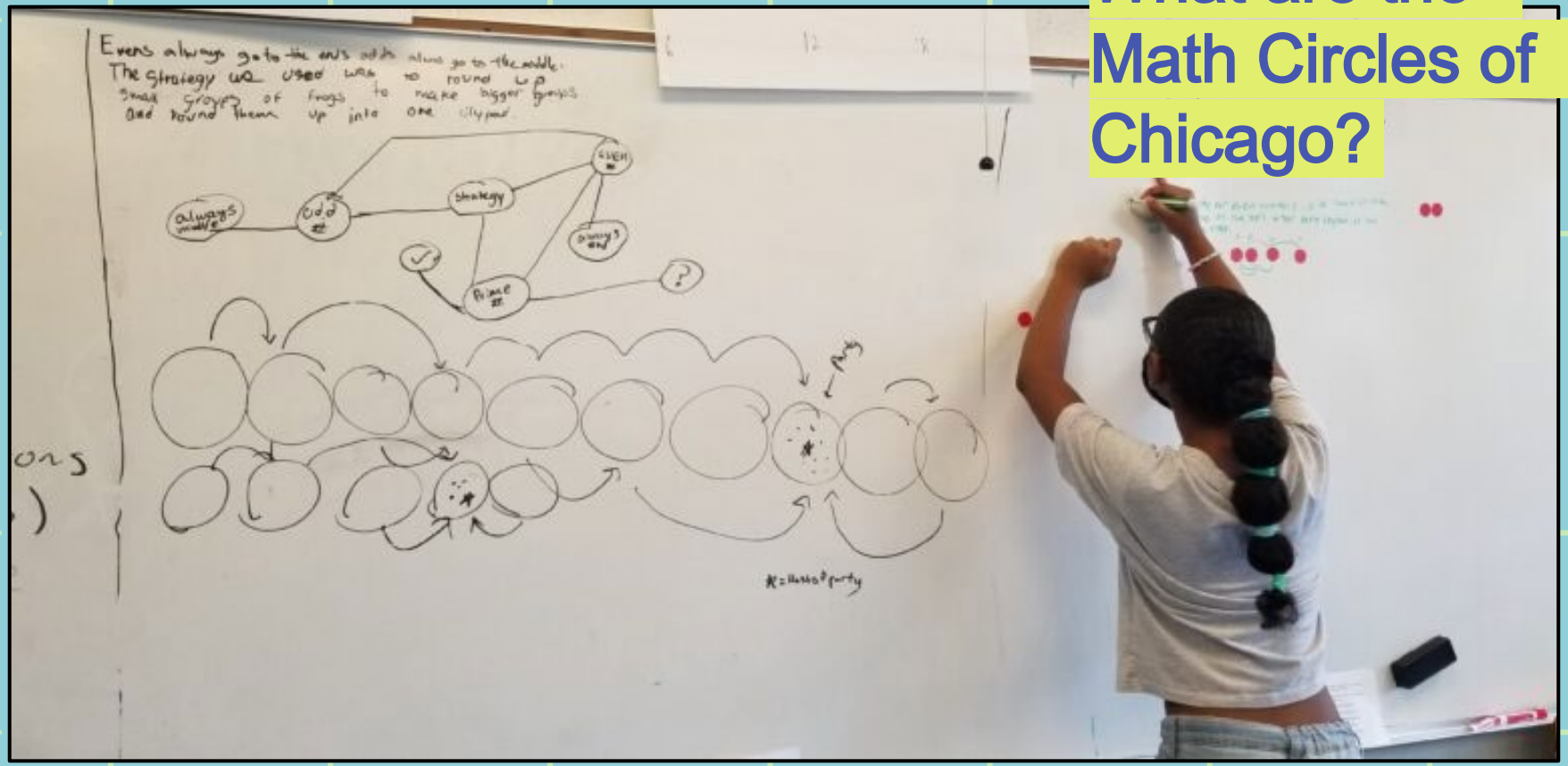


# Our Mission

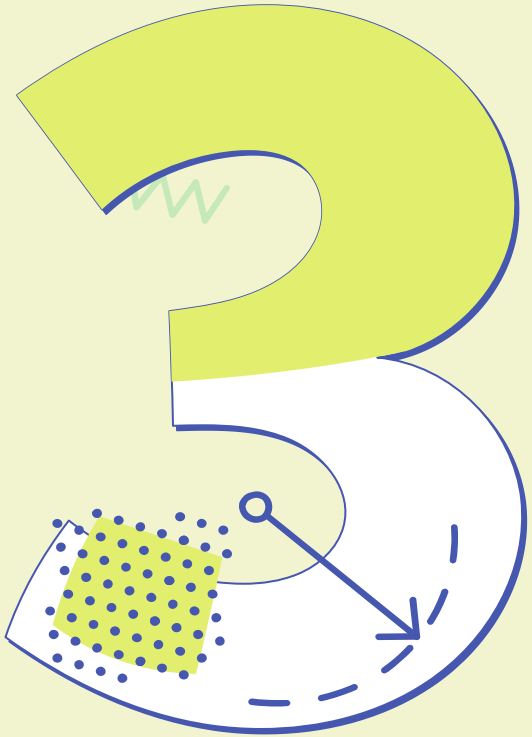
MC² MATH CIRCLES OF CHICAGO

*Math Circles of Chicago ($MC^2$) achieves its mission by providing free, unique enrichment programs for $5^{th}$ – $12^{th}$ grade students of diverse backgrounds*

MC²

***Create opportunities for all children across Chicago to develop a passion for Mathematics***

*All Chicago, Every Kid, Amazing Math*



# Diverse and Strenthening Pathways: Research & Results

03

# Math Circle Research

**“To put this result in terms of the “average” participant and non-participant, our findings suggest that if Kim is a long-term regular Math Circle participant, then she is more likely to increase how much she wants to do well at math for both intrinsic (attainment) and extrinsic (utility) reasons, and that this effect may accumulate over time. In contrast, non-participants are likely to slightly decrease over time in wanting to do well in math, and this effect may also accumulate over time.”**

# Math Circle and OST Impact

"Participating students reported increases in their interests in mathematics, their confidence in their ability to tackle mathematics problems, and in their enjoyment of mathematics."

--Math Circles: A Tool for Promoting Engagement Among Middle School Minority Males

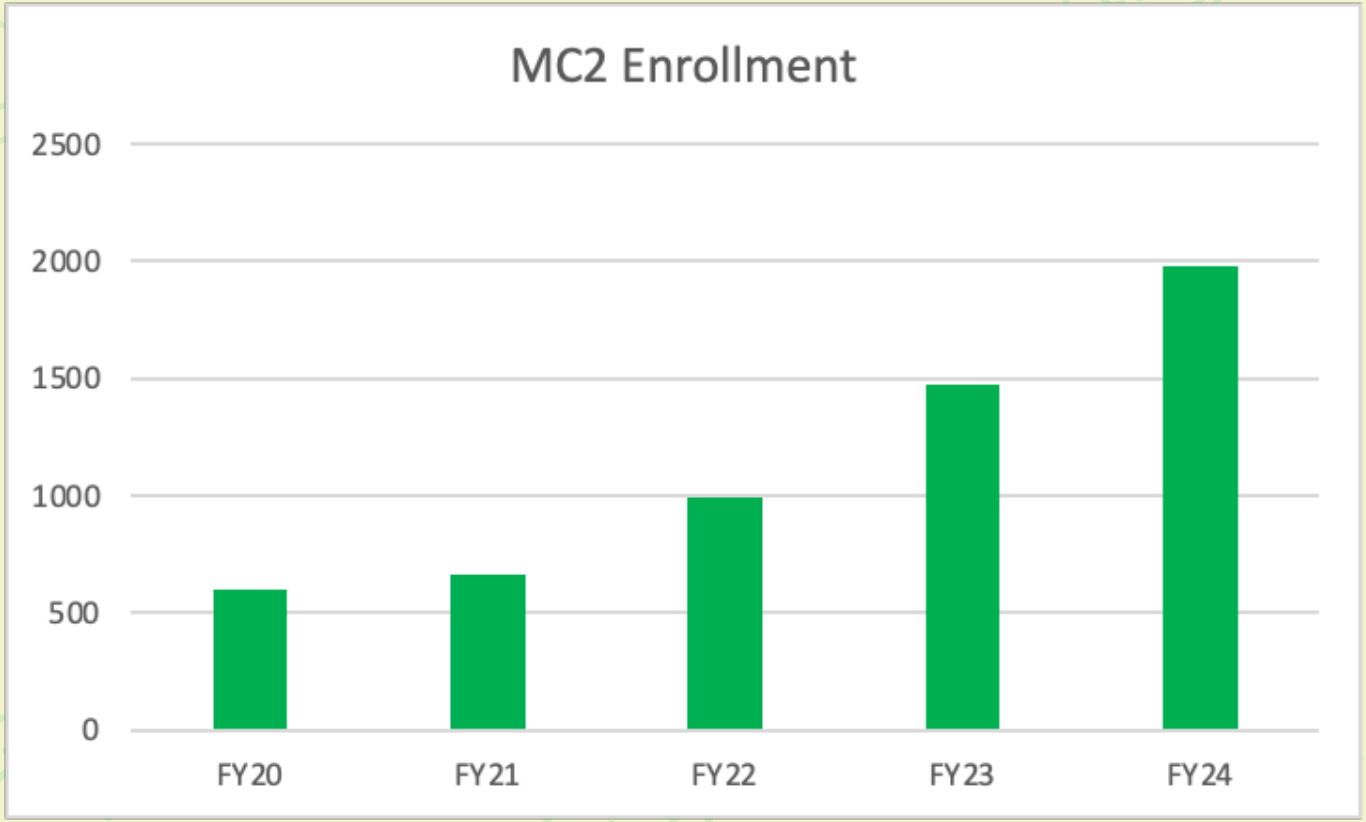
"Our overall conclusion is that OST programs are generally effective at producing the primary outcomes that would be expected based on their content and design."

--The Value of Out-of-School Time Programs

Researchers found that those who attended a five-to-six-week summer program for 20 or more days in 2013 did better on state math tests than similar students in the control group. This advantage was statistically significant and lasted through the following school year. The results are even more striking for high attenders in 2014: They outperformed control group students in both math and English Language Arts (ELA), on fall tests and later, in the spring. The advantage after the second summer was equivalent to 20-25 percent of a year's learning in math and ELA.

--Learning from Summer: Effects of Voluntary Summer Learning Programs on Low-Income Urban Youth

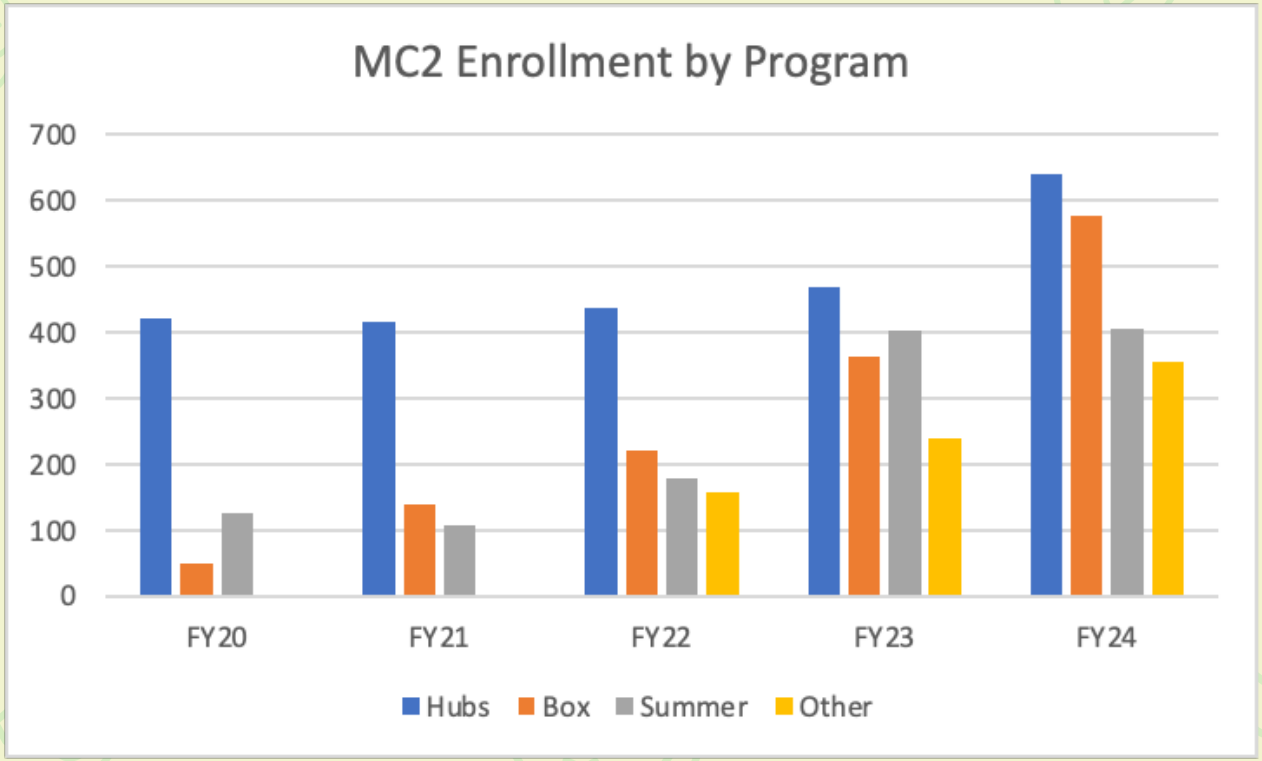
# MC2 Data: Getting to Scale




FY22 was the 2021-2022 school year--last year.

FY23 & FY24 are projections

# Getting to Scale: Varying Formats




FY22 was the 2021-2022 school year
FY23 & FY24 are projections

# An abbreviated REPORT CARD

96%

Surveys

100% and 75%

Retention Rates

63%, 66%, 48%

Demographics

# Quotes & Testimonials

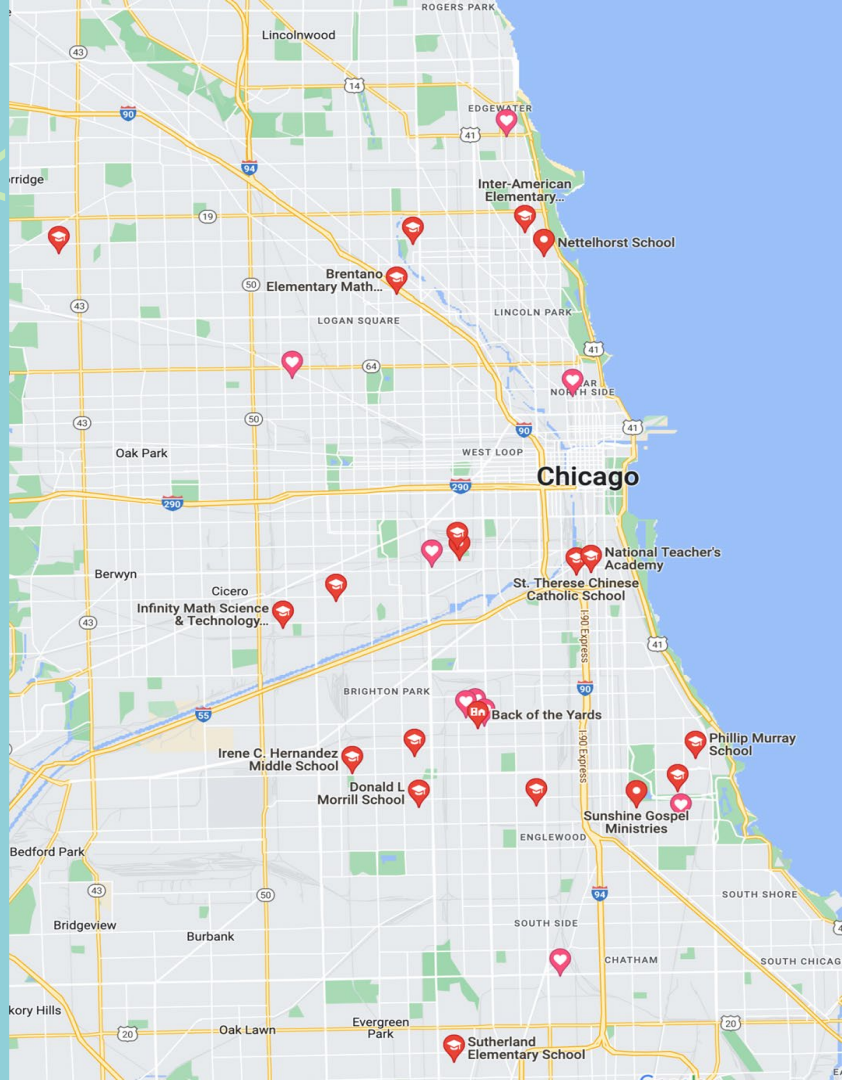
- MC2 Parent: “My daughter used to love math….
- MC2 Parent: “My child has so much fun in Math Circles that he asked me after todays session to PLEASE Sign him up [for summer]!”
- Students:
  - “I like the new problems and puzzles I never knew math had.”
  - “They teach us things that we don’t often learn at school. It’s not normal math like equations, it’s word problems that involve different thinking.”

# 04

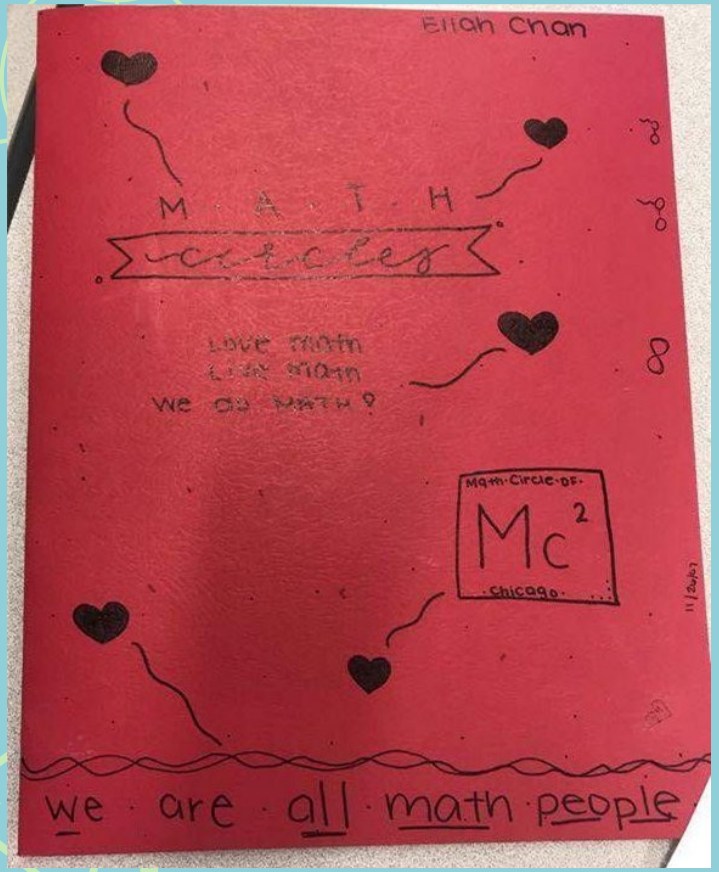
# HP Support and Shared Vision

# HP's Impact

- MC2 Growth
- Free and Local
- Experiments & Iteration



# Guiding Question Revisited




## Guiding Questions:

**What are the essential elements of an impactful, large scale math enrichment program? How can the engineering community engage in this work?**

# What's in your circle?

doug@mathcirclesofchicago.org
boz.bell@hp.com